



The Blast Furnace and Steel Plant

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The Blast Furnace *and* Steel Plant

Vol. X

PITTSBURGH, PA., APRIL, 1922

No. 4

Present Day Iron Blast Furnace Practice

The Metallurgist Rather Than the Engineer Is Now the Man on Whom the Present and Future Progress in Iron Blast Furnace Practice Depends.

By RALPH H. SWEETSER

Asst. to the Vice President, American Rolling Mill Co., Columbus, Ohio

THE present state of iron blast furnace practice is metallurgical rather than mechanical; the tendency is toward intensity rather than toward extension. The engineers have built blast furnaces big enough and strong enough, and have furnished accessory equipment ample and accurate enough for the present state of the art, but the metallurgical side has been too much neglected; the metallurgist, rather than the engineer, is now the man on whom the present and future progress in iron blast furnace practice depends. The mining engineer has produced great tonnages of iron ores, and has kept ahead of the demands for quantity; now the metallurgist is improving the chemical and physical qualities of this product by ore-dressing and other forms of beneficiation. For a generation or more, the principles of mechanics have had most influence in the advancement of iron blast furnace practice; attention now is given more to the principles of metallurgy, chemistry, and ore-dressing.

This metallurgical progress is taking place inside and outside the blast furnace. The two great determining factors of the inside operation are the slag, and the rate of combustibility of the coke. Outside the furnace, the progress is, and will be, along the lines of more careful mixing of ores and iron bearing materials, in the sizing and washing of limestone, and in the character and structure of by-product coke.

Blast Furnace Slags.

There have been almost as many theories on blast furnace slags as there have been blast furnace superintendents; and many of the theories were wrong, including my own.

During the war several important articles on blast furnace slag were published, perhaps the most notable paper being the one by Alexander F. Feild and P. H. Royster.[†] This article did not at the time receive the attention and discussion it deserved. Blast furnace men for the most part were concerned in keeping their plants in operation so as to produce the greatest possible tonnage, and there was practically no time for technical discussion. The paper, however, was of the utmost importance and brought out some facts contrary to the

general opinion of blast furnace superintendents. These facts are now receiving more attention and the information developed, and since proved, is being used in burdening the furnaces. Mr. Feild and those discussing his paper pointed to the fact that the information obtained by the use of pyrometers in determining the melting points of slag had helped to remove "another element of uncertainty from the problems encountered in practice." On the other hand, this same paper had some imaginings that did not sound at all practical, though it might be hard to disprove them.

Investigations are being carried on to determine the value of certain slags with special reference to the effect on the blast pressure and the general working of the furnace. The development of the investigations of the Bureau of Mines and of individual blast furnace men have upset many of the preconceived notions regarding the causes of blast pressure inside the furnace. Further investigations are necessary to demonstrate fully the relation between the composition of the blast furnace slag and "the sticking and slipping" of furnaces.

Slag Disposal.

The demand for crushed slag as an aggregate in concrete work has increased in recent years, and much blast furnace slag now goes to the crushing and screening plants. Dry pits and steam shovels are generally used. Where granulating pits are still in use, it is usual to throw the wet slag into piles in freezing weather so as to drain off as much water as possible before loading it into railroad cars.

Fluxes.

More attention is now being given to the question of blast furnace fluxes than was formerly considered necessary. As a rule, the limestone for blast furnace flux was chosen on the basis of cost and freight rather than quality, providing the carbonates of lime and magnesium made up about 95 per cent of the stone. Open hearth slag is being more commonly used, especially where the blast furnace is a part of the steel plant. This is an economical way to dispose of the slag from the open hearth, and it is a double source of metal and flux for the blast furnace. In some cases the amount used is 10 per cent of the total ore burden.

Magnesia is still a subject of controversy, but Mr. Feild's statement[‡] that "Magnesia (MgO), as such, does not affect the slag viscosity so far as practical pur-

*Reprinted from March issue of *Mining and Metallurgy*.

†Slag Viscosity Tables for Blast Furnace Work. Abstract in *Trans.* (1918) 58, 650. Complete paper published by Bureau of Mines as *Tech. Paper* 187.

‡*Op. cit.*

poses are concerned unless present in amounts greater than 8 per cent," is being more generally believed.

The size of the flux stone still varies greatly in the different iron making districts, and in many cases the run of the quarry crusher is accepted providing the fine dust is screened out. It is generally conceded that a closer sizing of the flux stone is beneficial; and where "ballast size" stone has been used there has been some improvement in the working of the furnace. At a few large quarries the stone is washed after crushing.

Coke.

"Poor coke" has been the excuse of many a blast furnace superintendent for the poor work of his furnace, and no doubt the poor coke deserved much of the blame; but, what is poor coke? The Coke Committee (Committee D-6) of the American Society for Testing Materials is even sending out questionnaires asking "What is coke?" Some of the poorest looking coke, judging by the old standards of luster, "longer fingers," and "metallic ring," now gives the best results in the blast furnace.

Exact specifications for a good blast furnace coke have not yet been generally accepted, but efforts are being made to find standard tests for determining the value of by-product cokes. The rate of combustibility has been brought forward by Herman Brassert and others as one of the determining factors of the value of a coke. Resistance to breakage is another quality that is desirable, for which a proper comparative test is being sought. Much valuable work in this direction is being carried on by J. C. Barrett, at the Ohio works, in his tumbling-barrel tests.

It is claimed that if the blast furnace men can specify a certain rate of combustibility, and a certain toughness of structure, it will be possible for the by-product coke oven man to produce the desired coke by carefully mixing the coals for the ovens.

There is need for much research work to determine the proper structure and size of cokes, and to find the right descriptive terms for the relative values of the different cokes.

Standardization.

The indictment brought against "the management" in general, in reference to the responsibility for the excessive waste in industry, has been well deserved by the management of most blast furnaces. Until recently there was not even an approximate rule for determining the tonnage that should be produced by a blast furnace of a given size. In many cases the coke per ton of pig iron at one furnace was compared with the coke per ton of iron at other furnaces without any reference to the quality of the cokes used or to their contents of fixed carbon.

The rule for rating the capacities of blast furnaces adopted by the Southern Ohio Pig Iron and Coke Association (published in the trade journals) is based on the burning of a certain amount of a "base" coke in a given time (60 lb. coke per cu. ft. of working volume in 24 hr.). Starting with the idea that there is a definite rate of combustibility for a standard coke, assuming that the ore mixture contains 51.50 per cent iron in the natural state, and arbitrarily using 1,800 lb. of coke per ton of basic pig iron when the fixed carbon in the coke is 90 per cent, it is a simple process to determine what any blast furnace should make under varying conditions

of coke, ore mixture, and percentage of silicon in the pig iron.

The general acceptance of a standard coke is the next step in the advancement of blast furnace practice. The United States Bureau of Mines, the American Society for Testing Materials, and other associations are trying to solve this problem.

In the operation of blast furnaces, especially at plants that began when all the pig iron was handled by man power and all the raw material was hauled in buggies, there has been too great a delay in getting rid of old customs and wasteful practices. Many of us can remember when blast furnaces 85 ft. high would have cover plates over the whole length of the casting trough at casting time. Even after the adoption of tap-hole guns, and electric drills for the iron notch, and casting machines in place of pig beds, there was a tendency to retain men in the cast house in greater numbers than needed. This was because there was no accepted standard for a day's work around the blast furnace. The adoption of these standards may seem to work hardships, especially in times of unemployment, but it is the only course to take if management is to get rid of the stigma of wasteful practices.

Beneficiation of Ores.

The physical qualities of iron ores are being improved by all the old methods of washing and roasting brought up to date, such as sizing (and crushing where necessary), washing, drying, nodulizing, sintering, and magnetic concentration. The sintering process has found extensive use in changing flue dust into a desirable blast furnace raw material; it is also successfully used in preparing fine magnetic concentrates for blast furnace use; in some instances the sintering process is used instead of roasting for the removal of sulphur.

Cost Accounting.

Great progress in blast furnace practice was made by the adoption of the Croxton Efficiency System with its uniform method of cost accounting. However, this method allowed only a comparison between one month's cost and another, or else only between the cost at one furnace and the cost at another. The only true comparison is between the actual cost for a given month and the standard cost for that month at that particular furnace. Such a comparative cost system has already been put into use.

The pig iron cost sheet at most blast furnace plants has been used almost exclusively as a guide for the sales department, and it has seldom been used in its other and more important function, as a guide for the successful operation of the blast furnace itself. Such a cost sheet, in order to be of full value to the furnace superintendent, must be promptly available and approximately accurate. When the actual amounts of ore, coke, limestone, labor and supplies, and the actual costs per ton of pig iron for these items, are compared with the ideal cost for that month, using standard amounts of materials and labor at the actual prices and wages, then, and then only, is a comparison made that is fair to the management, to the superintendent, and to the furnace.

In spite of the increased cost for freight in assembling raw materials for making pig, the location for new furnaces seems to be governed more by the market for the iron than by the location of any of the raw materials.

Electric Motors in the Steel Plant

Electric Motor Braking as Applied in a Steel Plant to Restrict Speed of Overhauling Load, to Cause Definite Slow Down and to Stop.

By GORDON FOX*

PART II.

DYNAMIC braking is sometimes employed in railway service and elsewhere, either with or without intent, through the action of two series motors, connected in parallel. Under certain conditions such motors will act in series to set up a braking current through their local circuit. This action may be best considered with the aid of the simplified diagrams in Fig. 5 a.b.c. Fig. 5a shows two series motors in railway service, connected in series. The arrows indicate the direction of current flow and armature counter-voltage. If the reverse switch be thrown and the main drum turned to a parallel position, the conditions are as shown in Fig. 5b. This is but a mo-

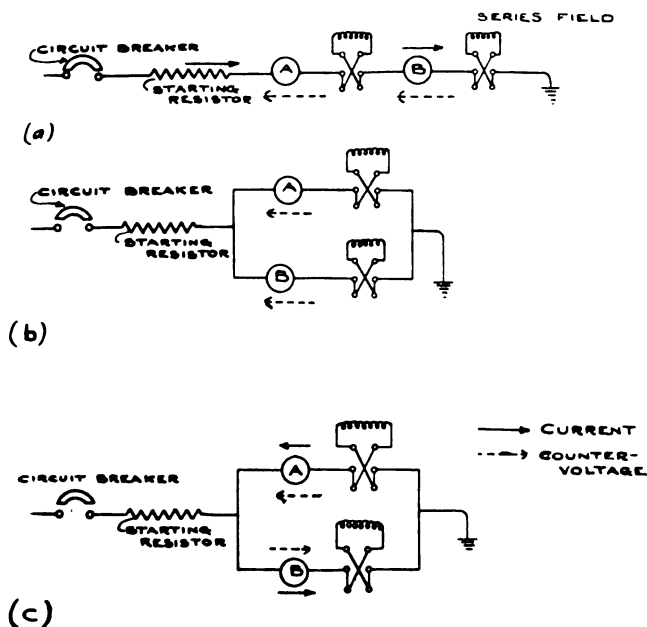


Fig. 5—Connections showing "bucking" of two series motors connected in parallel.

mentary condition, however. Due to the slight inherent differences which always exist between any two motors of the same design, one motor will have a higher residual magnetism than the other. This motor (A) will build up voltage more rapidly than the other (B). It will then tend to circulate current through motor B, overcoming the residual voltage of the latter and will reverse the field and consequently the voltage generated by Motor B. A local current then flows, as indicated in Fig. 5c. This braking current, flowing through the two motors in series, short circuited, is likely to reach severe values and may result in flashing or damage due to the mechanical shock of the sudden torque. This procedure should therefore be

*Electrical Engineer, Freyn Brassert & Co.

restricted, in railway service, to emergency condition. However, this condition may and sometimes does arise in other applications where two motors are paralleled, using a single set of starting resistors. Where two sets of starting resistors are employed, one for each motor, as indicated in Fig. 6, the local series circuit includes the starting resistors which suffice to prevent or restrict the flow of current in this local circuit. It

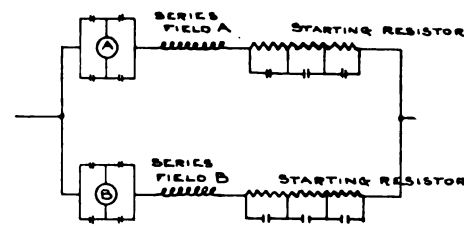


Fig. 6—Two series motors in parallel provided with separate resistors.

is possible to prevent the flow of circulating current in a closed loop caused by reversing two series motors connected in parallel by interchanging the series fields, as indicated in Fig. 7. With this arrangement any unbalancing is quickly corrected. Sometimes an equalizer connection is used, connecting the armature-series field junction points of the two motors, for like purpose. This arrangement is indicated in Fig. 8. It is

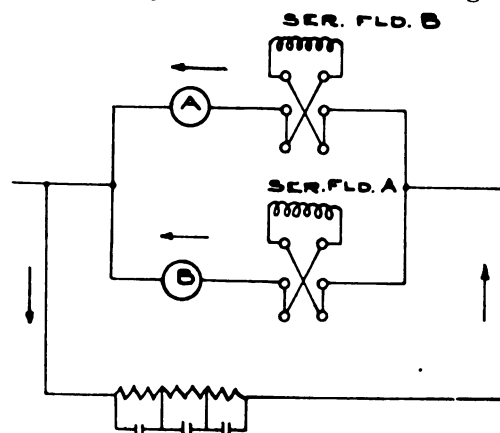


Fig. 7—Arrangement used in railway service for electric rheostatic braking. The series fields of the two motors are interchanged when reversed.

simpler than that of Fig. 7 but not so positive in corrective action.

The alternating current induction motor is not inherently adapted for dynamic braking service. The load current and magnetizing current flow through the same winding and from a common source, and cannot be dissociated. Two schemes have been developed and

applied for obtaining dynamic braking from induction motors. In both schemes direct current is applied to the primary winding to create a fixed magnetic field. The rotor conductors, cutting this field, generate voltage and circulate current in their secondary circuit. The braking torque may be governed by the amount of

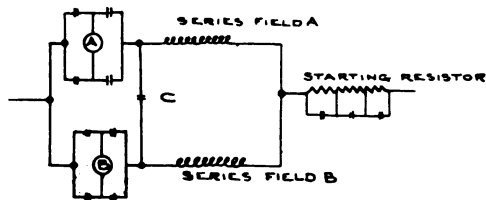


Fig. 8—Two series motors in parallel provided with equalizing connection. Contactor "C" open while motoring and closed while braking.

direct current in the primary and by the resistance of the secondary circuit. The amount of direct current introduced into the primary is in general magnitude comparable with the full load alternating current. The direct current supply must be at low voltage because only the resistance of the primary windings is involved. In one scheme the direct current is obtained from a small motor generator set which, in turn is excited from an auxiliary exciter. In another scheme the direct current is obtained from a generator which is mounted on a common shaft with the induction motor. This unit has its field winding excited from a tungar rectifier. The latter scheme offers some advantage in that the auxiliary dc. unit assists in braking, the braking current is automatically adapted to the load and the direct current excitation automatically ceases when the motor stops. The principal connections for these two systems of braking are shown in Figs. 9 and 10.

It is possible to obtain dynamic braking with the synchronous motor. This is accomplished by disconnecting the primary leads from the line, while the motor is running, and then short circuiting the primary through suitable resistance. The excitation of the field poles is maintained, at least in part. The rotating flux generates voltage in the primary, resulting in a braking current flowing through the primary windings and

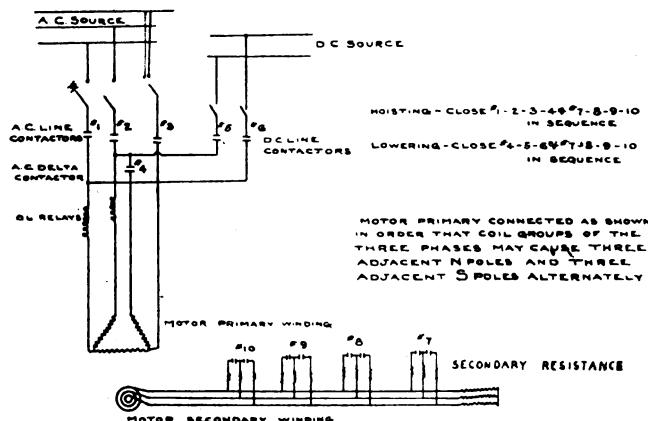


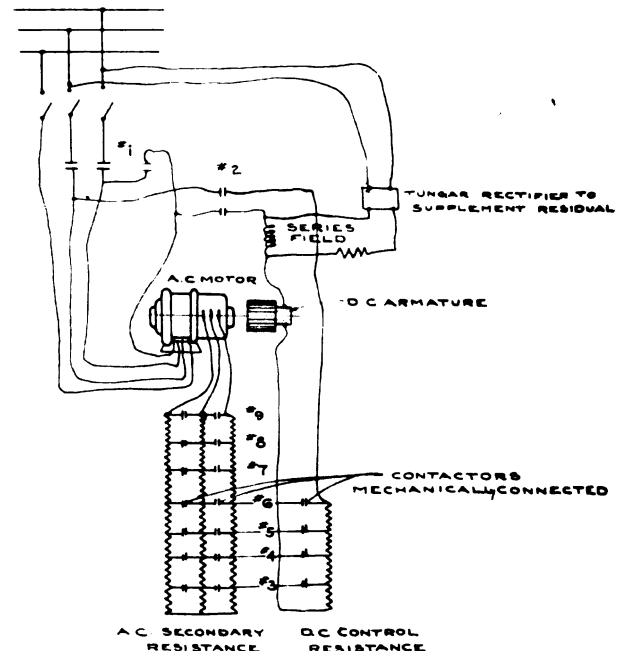
Fig. 9—Dynamic Braking with induction motor.

the external short circuiting resistance. This arrangement has been used effectively in the rubber mill for obtaining a very quick emergency stop.

If a direct current motor, running at full speed, have its starting resistance suddenly inserted in circuit there will be little or no electrical braking effect.

The driving torque, will, of course, fall off and friction or load will slow down the machine, opposed by inertia. In case the load is overhauling the motor will speed up. Dynamic braking can be employed to obtain a definite slow down from full speed to a fixed lower speed, by connecting resistance in parallel with the armature, which is connected in series with the starting resistance. The voltage drop in the series resistance reduces the voltage at the motor terminals to a value lower than its countervoltage. Current is then forced by the armature through the parallel resistance in a direction to cause braking action until the armature slows down and the countervoltage drops off. The motor will quickly come to a speed corresponding to the reduced terminal voltage, the exact speed depending upon the values of series and parallel resistance and upon the load.

This action is obtained, with a shunt wound motor,



HOIST—CLOSE CONTACTORS 1-3-4-5-6-7-8-9 IN SEQUENCE
LOWER RAPIDLY—CLOSE CONTACTOR 2
LOWER SLOWLY—CLOSE CONTACTORS 2-3-4-5-6 IN SEQUENCE

Fig. 10—Principal connections of dynamic braking control with induction motor direct connected dc generator.

by shunting the armature with the parallel resistance. With a series motor, the armature may be shunted by the resistance or the entire motor may be shunted, see Figs. 11 and 12. Shunting the armature alone causes a more pronounced braking action as the series field flux is well maintained or may be strengthened (depending on relative resistance values). Shunting the entire motor causes a less severe and less effective braking action. The low speed obtained with shunted armature is fairly constant, with either shunt or series motor but falls off somewhat under load. The regulation depends upon the series and shunt resistance values. Fig. 13 shows the speed current curves for a skip hoist motor, compound wound. Two slow down points are shown. The motor is a simple shunt motor while running, having the characteristic curve No. 1. On the first slow down point the series field winding is introduced, the starting resistance connected in series and the armature shunted with resistance. On

the second slow down point the shunting resistance is reduced. It should be noted that, if complete slow down were attempted in one step, there would be a very high initial rush of braking current, corresponding to full speed (300 rpm) on curve No. 3 and braking would be severe. It should also be noted that the torque developed on the slow speed points is relatively low and the motor may stall if the armature is too heavily shunted.

The wound rotor induction motor is similar to the direct current motor in that a definite slow down cannot be obtained by insertion of resistance in either primary or secondary circuits. A slower speed will eventually result but will not be attained through any marked braking action developed by the motor. The multispeed induction motor is applied, however, to

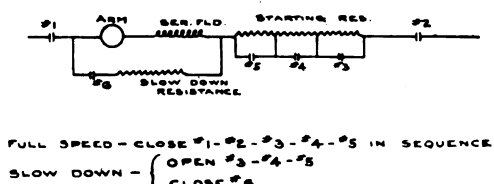


Fig. 11.

obtain a definite slow down. The motor is run on its high speed winding, the low speed winding being utilized for the slow speed. At the instant of change over, the rotor is revolving at a speed exceeding the synchronous speed for the low speed winding. The motor acts temporarily as an induction generator with reversed torque. The action may be more evident by inspection of the curves in Fig. 14. It will be noted that the braking current at the instant of change over may be very high. In some cases external resistance is inserted in the secondary circuit of a wound rotor motor to minimize this effect. In some cases a high resistance cage motor is employed. This has a less flat characteristic and the current inrush is lower. Pri-

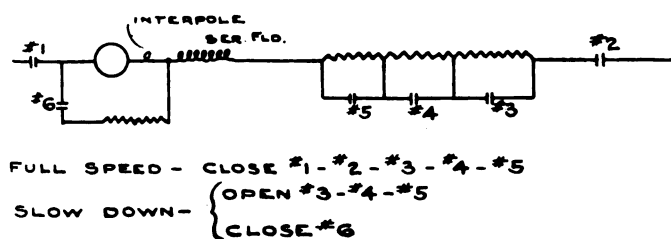


Fig. 12.

mary resistance is also used with some cage motors.

A somewhat special case of dynamic braking is employed in crane hoist service. The direct current series motor is most commonly used. When lowering a light hook, it is necessary that the motor drive downwards as the weight is usually insufficient to overcome the friction of the hoist. In lowering heavy loads, the motor must retard. This double duty is accomplished by connecting the motor as a shunt machine by placing the series fields across the line in series with resistance. The armature is also connected across the line, in series with other resistance as shown in Fig. 15. The solid arrows show the direction of current flow when the motor is driving down a light hook. The dotted arrows show the flow of retarding current. The latter may be largely or entirely confined to the local circuit comprising armature series fields and armature resist-

ance. In some controls the line is disconnected after the load overhauls. It should be noted that the braking influence is adjustable and the lowering speed adjustable, depending upon the resistance in the armature and series field circuits. These resistances are varied on the different control points. Fig. 16 shows the characteristic curves for the various control points.

A word may be in order concerning the uses and

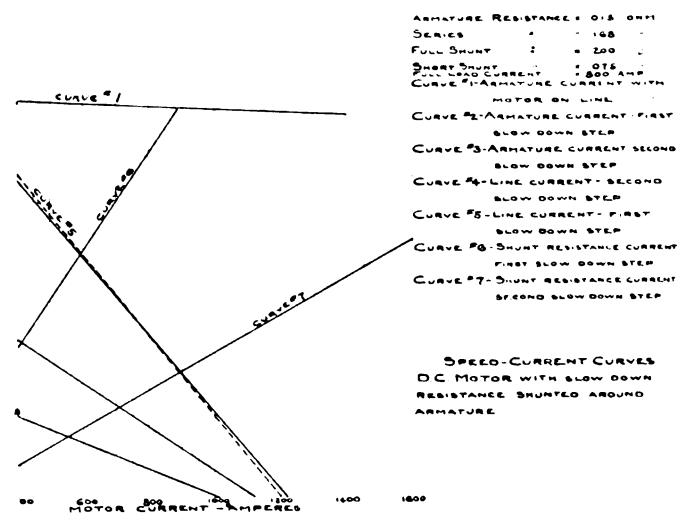


Fig. 13.

advantages of dynamic braking. These have been already suggested. Perhaps the most extensive application is in crane and hoist service for lowering. Elevators employ dynamic braking both for slow down and for stopping. Skip hoist control uses it similarly. Machine tools use dynamic braking to obtain a quick stop. Some reversing planers use it to bring the plater

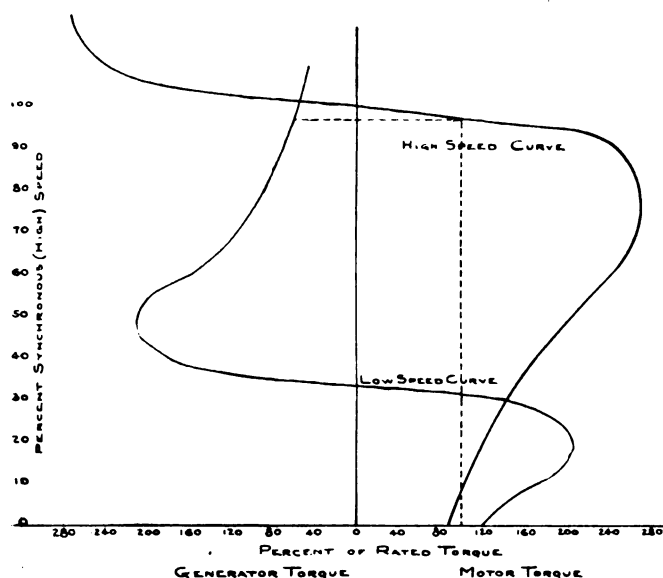


Fig. 14—Speed torque curve of two speed (3 to 1) induction motor.

to a stop prior to reversing. Dynamic braking is used extensively on steel mill auxiliary drives, such as the screw down, to obtain a quick stop. It is used on ore and coal bridges for lowering the bucket and also for stopping the man trolley. It is used on the ingot buggy to obtain a slow down. There are many other less general and less conspicuous applications.

The advantages of dynamic braking are many. It has proven superior to mechanical braking on cranes and hoists. The principal advantages, here as elsewhere, are the nicely graduated control and the freedom from mechanical maintenance. The upkeep of friction brakes used for retarding or stopping is likely to be difficult and expensive. With dynamic braking most of the heat is dissipated in resistors situated apart from the motor. A brake on the motor shaft may transmit heat to the motor to a serious extent. Dynamic braking is easily adjustable and maintains its adjustment. Friction brakes require frequent adjustment and are affected by water and oil. Dynamic braking is quicker in action as most brakes have an appreciable time lag. Dynamic braking is sometimes

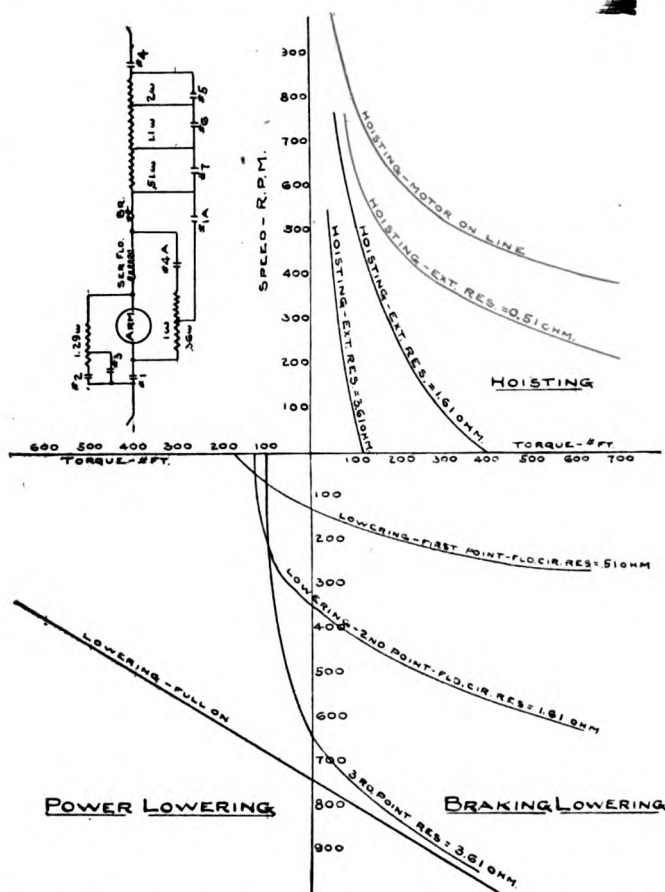


Fig. 16—Characteristic curves—dc series mill type motor with magnetic crane hoist controller. Showing action on various hoisting and lowering points.

used and supplemented by mechanical brakes. The dynamic braking reduces the speed to a point where this method of braking becomes ineffective. The mechanical brake then stops the motor.

This topic would not be complete without considering the work which must be done in stopping a motor and its driven load. When the driving power is removed and braking applied the inertia of the motor and moving machinery tends to continue the motion. It is necessary, in braking, to dissipate the kinetic energy stored in these parts.

The energy stored in the motor armature or rotor is E_A

$$E_A = \frac{W_r^2 \times \text{RPM}_A^2}{5870} \text{ ft. lbs.}$$

Where W_r^2 = moment of inertia of the armature, weight $\times$ radius of gyration 2 .

RPM_A = rotative speed of armature.

The energy stored in the rotating machine parts computed at any selected shaft is E_m

$$E_m = \frac{W_m R_m^2 \times \text{RPM}_m^2}{5870} \text{ ft. lbs.}$$

Where W_m = weight of revolving members—lbs.

R_m = radius of gyration revolving members—ft.

RPM_m = rev. per min. of selected shaft.

The energy stored in parts having linear movement may be determined by considering same as concentrated at wheel rim or drum periphery, as the case may

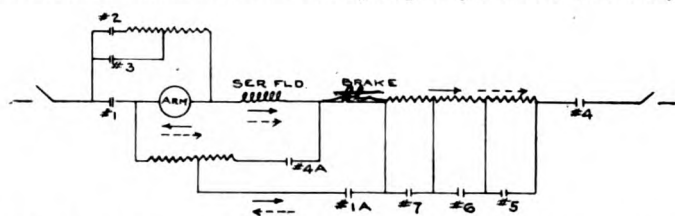


Fig. 15—Diagram of principle connections. Direct current crane hoist control. Solid lines indicate current flow when driving downward. Dotted lines indicate current flow when restraining overhauling load.

be, or by considering linear forces. For instance, in a hoist, the energy stored in the moving suspended load is E_H .

$$E_H = \frac{W_H}{64.32} \times \left(\frac{V}{60}\right)^2 \text{ ft. lbs.}$$

Where W_H = weight of all parts in linear motion. Lbs.

V = linear velocity — ft. per min.

The work done by or against gravity on the unbalanced portion of the suspended load, as in the case of a hoist, is E_G .

$$E_G = \frac{W_u V_t}{120} \text{ ft. lbs.}$$

Where W_u = unbalanced weight — lbs.

t = time to stop — seconds.

The net or total energy of the load, to be absorbed by the motor or brake is E_N .

$$E_N = \frac{W_H V^2}{230,000} \pm \frac{W_u V_t}{120} \text{ ft. lbs.}$$

Use + for stop while lowering.

Use — for stop while hoisting.

This is in addition to the kinetic energy of the motor armature and revolving parts of the hoist.

TO ADVISE CHINA PROJECT

The Trumbull-Cliffs Furnace Company has retained Freyn, Brassert & Company, Chicago, in connection with extensions to electrical power output, at its blast furnaces at Warren, Ohio. The Chicago company also has been retained by the Kailan Mining administration, China, as consultants in concentration and mill tests on their low grade magnetic ores.

Efficient Arrangement of Open Hearth Labor

Reduction of Forces by Better Distribution of Men and Occupations in Operating a Modern Open Hearth Shop.

By P. S. YOUNG

THE reduction of forces in plant operation has always been and always will be an aim, as it reduces the cost of the product, the labor turnover, the expenses of timekeeping, and increases the amount which can be paid each man for his work. At this time it comprises one of the gravest issues in production topics, for several other reasons:

(1) As we come back to normalcy the prices of the product and of labor must come down, and yet production must be increased. To do this men must either work at a figure which will give them bare existence until the other fellow's goods come down to make the cost of living generally lower, or else the number of men to manufacture the product must be decreased thereby allowing a higher rate per man, but giving the product to the consumer at a cost which he will be able and willing to pay.

(2) The second reason seems more empirical but is none the less true. At the time of the last great business depression it was necessary to lay off practically all the less important employees of the Steel Mills. This of course occasioned great privation and suffering, which will not be quickly made up by work at a low rate as the men will have to apply all their earnings to the daily necessities while working for low pay and will be unable to make up for expenses incurred during their previous period of unemployment. Thus we see, that any steps taken by the employers to decrease the number of men necessary for each process of manufacture and tending to hold wages at their present rate without further reduction is most essential to those employed in the manufacture. Also, when the next cycle of business approaches a depression the number of men to be laid off will be less in each process. From one point of view it would appear that the smaller number of men employed in the manufacture of any product would tend to keep large numbers of the unemployed from regaining employment. This, however, is not true. As soon as the factories, mills and railroads begin turning out and carrying products in quantity, unemployment will vanish and in its stead will come an actual shortage of labor. In fact, this efficiency will rather tend to balance the shortage of labor in times of high speed manufacture with the lack of employment at the times of business depression.

Let us now look at an average Open Hearth force for a twelve 100-ton Furnace Plant. It will run about the following, beginning at the Metal Mixer and ending at the Stripper and Mold Yard:

Metal Mixer

1 Mixer Craneman, two turns.....	2
1 Mixer Boss, two turns.....	2

3 Helpers, two turns.....	6
1 Mixer Ladle Skuller, two turns.....	2
6 Total.....	12

Stock Yard

4 Stock Cranemen, two turns.....	8
1 Stocker Boss, two turns.....	2
8 Scrap and Metal Loaders, two turns.....	16
4 Ore and Limestone Loaders, two turns.....	8
1 Oil Man, two turns.....	2
1 Buggy Repairman, one turn.....	1
1 Buggy Repairman Helper, one turn.....	1
20 Total.....	38

Charging Floor

3 Cranemen, two turns.....	6
2 Melter Foremen, two turns.....	4
12 First Helpers, two turns.....	24
12 Second Helpers, two turns.....	24
12 Third Helpers, two turns.....	24
1 Metal Chaser, two turns.....	2
2 Weigh Ups, two turns.....	4
6 Pull Ups, two turns.....	12
2 Test Boys, two turns.....	4
52 Total.....	104

Pitside

3 Cranemen, two turns.....	6
1 Pit Boss, two turns.....	2
2 Steel Pourers, two turns.....	4
4 Steel Pourers Helpers, two turns.....	8
2 Platform Men, two turns.....	4
1 Ladle Liner, one turn.....	1
2 Ladle Liner Helpers, one turn.....	2
1 Stopper Setter, two turns.....	2
1 Stopper Setter Helper, two turns.....	2
1 Nozzle Setter, two turns.....	2
1 Nozzle Setter Helper, two turns.....	2
1 Steel Shipper, two turns.....	2
1 Ingot Scales Weigher, two turns.....	2
21 Total.....	39

Mould Yard and Stripper

2 Stripper Cranemen, two turns.....	4
1 Mold Yard Craneman, two turns.....	2
1 Mold Yard Boss, two turns.....	2
4 Mold Scrappers, two turns.....	8
8 Total.....	16

Mixing House

1 Foreman, two turns.....	2
1 Craneman, two turns.....	2
3 Pan Men, two turns.....	6
4 Dolomite Shovelers, two turns.....	8
1 Coal Drier, two turns.....	2
1 Stopper Maker, one turn.....	1
11 Total.....	21

Open Hearth General Labor Gang

1 Foreman, one turn.....	1
12 Laborers, one turn.....	12

Millwright Department

1 Millwright, two turns.....	2
1 Millwright Helper, two turns.....	2
2 Total.....	4

Electrical Department

1 Electrical Inspector, two turns.....	2
2 Helpers, two turns.....	4
5 Total.....	6

Office

1 Superintendent, one turn.....	1
1 Assistant Superintendent, one turn.....	1
2 Clerks, one turn.....	2
1 Timekeeper, two turns.....	2

Thus we find a total of 259 men employed on two turns or 142 men on day turn and 117 men on night turn. This is about the number of men employed normally for a twelve furnace shop. Of course at times of furnace repairing the number is increased. Now in a twelve furnace shop there is one furnace off for repairs practically all the time, and if not it is usually because some furnaces are going bad before their allotted time, in which shop we will find several furnaces off at one time and all on at another. For the sake of consistent production this should be avoided as much as possible and an effort should be made when a furnace comes off out of its turn to assign it a new turn and try to hold the other furnaces scheduled to come off long enough to allow the new order of repairs to adjust matters. This condition is most pronounced in shops where the fuel used is more injurious to the brickwork or where such exceptional stress is laid on quantity production that the workmen fear no criticism as much as that on low production. As repair work on furnaces does not come under the head of steel production labor, and the reduction of the repairing force in number of men can not be well dealt with in this paper, we will not consider these as a part of our force in this discussion.

The reduction of the producing force of men can be met in two ways, by the installation of labor saving machinery, taking the dolomite gun as an example, and the well considered and carefully thought out rearrangement of occupations. The rearrangement of occupations is not with the idea of grinding more work out of each individual but (1) of filling in the unnecessary periods when on account of the spasmodic character of Open Hearth work certain of the workers are not only idle and resting but so idle that they become restless, (2) the interweaving of several occupations showing a saving on each, (3) better shop teamwork on all lines of work rather than the attitude of specialization, (4) and this results in a more easily controlled and more elastic organization. In regard to the idle time mentioned above, there is no doubt in the world that it exists and even to a point where it is detrimental to the organization. This appeared in many shops at the time of the great flu epidemic in the Fall of 1918. In spite of the fact that about half the workers were absent the steel companies kept up production at a greater than normal rate. In some shops, of course, where the numbers of employees absent were more than half of the shop organization, and those who were working were nursing sick members of their families at home or were just returned from an attack and still sick, there was a slackening of production, but not at all in a ratio to the absentees. And for some time after the epidemic it was quite

noticeable that the morale of the organization was improved. This leads us to the conclusion that a reduction in the working force means a raising in the morale of an organization when judiciously employed toward that end. The various Safety Departments will readily back me up when I say that more accidents are caused when men are engaging in horseplay or sleeping than in the regular functioning of their duties. It is the idle periods which cause men to resort to horseplay, and sleeping is an invitation to the mischievous ones to play some practical joke on the drowsy partner, while for a short time after a man is aroused from sleep he is more inclined to make miscalculations and be the victim of accidents which could have been easily prevented were he in a normal state of senses. Likewise, given a man with a set piece of work to do like the watching of a furnace as the job of a first helper. No one would consider having a first helper turn his attention to any other work than that of watching his furnace and turning out his heat of steel. This man, too, is usually not of the makeup that will lend a hand to horseplay or will be found sleeping on the job. The responsibilities of his occupation and his usual maturity eliminate those factors. Nevertheless, such a man is effected by the general attitude of those round about him, whether it be one of idleness or industry. With the rest of the organization on their toes the first helper will increase in efficiency and will be more watchful of his bath and more rapid in his judgment. Better teamwork is assured by having the men acquainted with more than one line of work in case of a shortage of men for a short time the organization will be better able to close up the gap left by the absentees. In the minor occupations where the rearrangement of the men will take the greatest effect, the men will have more diversity of occupation and it is from these men that at a later date will be drawn the men for the higher and more specialized occupations. When men are loafing and are not engaged in horseplay they are reading, talking, or gossiping. If they are talking of their work they are accomplishing a great deal in their industrial education. It is far from time lost. This is their school, and this is their method of study. If a majority of their talk were upon these lines it would be a loss to divert them from it. But, alas, how much of the conversation is spent in topics of this kind? Much of the talk is in the nature of gossip, some more is the recital of grievances real or imagined, and a little, a very little, is worse. At a few places, especially if there is any industrial unrest in the air, the agitators of their fellow men have fine opportunities to question some and answer others more loyal to the company from which they are earning their daily bread, little portions of the shop become forums, and quite a deal of mischief can be hatched before the culprits are discovered. Men most readily magnify imagined wrongs when they are restless and idle. These are some of the reasons for which the rearrangement of work may be valuable to the organization.

Reduction in the Open Hearth Office.

Two clerks and one timekeeper are shown, besides the Superintendent and his Assistant. In regard to the two clerks, try one with certain of the charging records or steel records turned over to the weighmasters. Or, if a time clock can be introduced do away with the timekeeper and turn his work over to the clerks. With the time clocks their labor will not

be found burdensome. The writer does not approve of the elimination of the Assistant Superintendent, if for no other reason than that someone must fill in during enforced absence of the Superintendent, and someone should be his understudy in case of his departure to other labors. Besides he should be the one to do the field work of the department, while the Superintendent should supervise everything, attend matters of furnace practice and construction, and determine the policies of the organization of his shop. The Superintendent should have time during his other work to discover and overcome any discrepancies in his steel, any lowering of furnace or pouring practice, and any interdepartmental controversies. It goes without saying that he cannot rightly perform all these functions unless he has assistance from one who is directly under his command. No melter foreman can take the place of an Assistant Superintendent.

Reduction at the Metal Mixer.

This paper assumes that the ladles are skulled at the Mixer. If they are not, they are at least skulled under some crane. By the use of a ladle skulling stand and the proper lining and plastering of ladles, iron skulls may be easily removed. The ladle stand in thought is one which consists of two arms which may be strapped to the arms on the trunnion of the ladle. The ladle bottom lug is attached to the bottom lug of the ladle which is raised until the hook slips off, when the 1 ladle drops with a great force on the stand. When the skull is somewhat loosened in case of a stubborn skull (in an easy one it can be at once lifted out of the ladle) the straps are attached to the trunnion arm and the skull is pulled loose from the ladle lip. If the Ladle Skuller be eliminated, the three Mixer Helpers can take care of his work with a skulling stand. A time study should be made of the three Mixer Helpers to see if one of these cannot be eliminated.

Reduction in the Stock Yard.

Here again enters rather the reduction by labor saving machinery than by rearrangement of occupation. A trestle with bins for the limestone and ore charge is a well known but potent factor in the reduction of labor at this point. If this cannot be effected, the nearest approach is a trench on each side of the cars at the point in the Stock Yard in which can be set the charging boxes which receive these commodities. In plants where no account of some local condition or a reloading from stock piles, the limestone and ore are loaded in gondolas, the center of the car can be unloaded by shovel and hand and when the bottom shows, a large bucket with teeth will unload the remainder of the car. The use of the large 60 in. magnet for scrap should be universal. No smaller magnet can be just as good. Also in two plants the writer noted cars of ten per cent silicon and seventeen per cent ferro phosphorus being unloaded by hand into storage piles under the magnet cranes. In both cases he was told by the stocker boss that they could not be unloaded by magnet and in both cases when tried they were so unloaded. One would think that until these commodities had been found to be non-magnetic that the attempt would be made to unload them the easier way. By a study of your Stock Yard, unless it is very unusual, the number of scrap and metal loaders can be fixed at six, and if overhead loading can be arranged for commodities such as limestone and ore the men at the bins should be two. Just one word

more on the Stock Yard. By no means cut the number of men to a point where it hurts. In no place can production be as quickly effected as in this yard. The delays in the Stock Yard are irretrievably lost. Time lost there can never be made up. The stock will not melt until it is in the furnace, and to disorganize the Stock Yard is to lower production. The Stock Yard has to adapt itself to changing conditions, from scrap that takes little labor to level to scrap that is awkward to level or does not pack well and all this change in the shifting of a few cars. Many an Open Hearth record lies rotting in the Stock Yard because those in charge of the plant's operations could not see the necessity for a little good scrap mixed with the bad. And after the scrap is in the furnace the trouble is not ended. A furnace charged too slowly or with badly packing scrap is in an excellent way for a "sticker."

Reduction on the Charging Floor.

There can be no reduction among the Melter Foremen or the First Helpers. Two Melter Foremen at least are needed for twelve furnaces and in some shops three would be an advantage. Each of the First Helpers has his hands full if he takes the proper care of his furnace and the working of the heat. Nothing can be added to him even should a large part of each turn be spent in apparent idleness. Not so with the Second and Third Helpers. Their work does not entail the actual responsibility that the First Helper holds. I feel sure that some one will say that the Second Helper is responsible for the tapping hole. He should not be. The First Helper should be held responsible for every part of the furnace, and this responsibility should not stop at the floor. It should extend to the checkers. The writer believes that a combination of Second and Third Helper would be one very good way to rearrange the duties of each of these occupations. The furnaces could be divided into batteries of three each. For each of these batteries four men would be sufficient to do the work of the Second and Third Helpers. They would constitute a gang which would be used in both branches of work, and two of these gangs would make bottom after heat was tapped. Unless the pits of the furnace are of the deep variety, or unless some other condition is extremely bad either in the construction of the shop or the handling of such commodities as furnace additions and loam, dolomite, etc., we see no reason why this system would not work out. And in such cases surely the addition of another man to the gang would be sufficient, and would constitute some saving. The labor saving devices on the Open Hearth floor and Pitside are in such an advanced state that it is really getting to be a time when we can decrease the number of men in the Open Hearth operations at these points. Most Open Hearths employ boys as pullups. Some employ the First Helper as a pullup. That is not so good. In this case we take away the service of an experienced shoveler at the time when the heat is working, or if the First Helper does the shoveling and does not work his doors a great deal of heat which should be retained in the furnace is going out of the door. At best it is a bad makeshift. Why not employ men to do the pulling up and have them attend to the cleaning up of the shop, the carrying of tests to the laboratory, and perhaps the wheeling of the ladle additions if shop conditions are such that these cannot be handled by the cranes. In this way the small boy is eliminated from the shop both as a test boy and pullup, and most Open Hearth men will

rejoice with me in the removal of the small boy both as a mischief maker, an unreliable adjunct, and as a butt for horseplay. The duties of the Metal Chaser may be filled by the Weighup with telephone connections to the Mixer from the Scales.

Reduction on the Pitside.

On the Pitside the changes cannot be so radical as on the Charging Floor. However, the Pit Boss and Shipper can be combined in most cases, and the shipping notices can be sent to the Pits by one of the platform men. The number of men on the Pitside is hardest of all to determine as so much depends on what quality of steel the Open Hearth is making, into molds capped or uncapped, or bottom or top poured ingots. The Pitside figured above is concerned with top pouring ingots which are capped. But in this case we believe that at least one man and more, probably two, can be eliminated from each of the two pouring gangs. We believe also that the inspection of the Pouring Platform should be rigidly kept up by the Pit Boss in the interests of safety, as the Pitside today stands as the great hazard in the Steel Plant. Not that the Ladle Liner has two helpers. If a lining pit were installed one helper would be enough as he could pass the brick to the liner standing in the ladle. Where no pit has been possible, the writer has found it convenient to use the liner and his helpers to make small patches in bulkheads where hot spots appeared and to line spouts and even badly worn places in the charging floor.

Mold Yard and Stripper.

In the Mold Yard a great labor saver is an old cylinder with arms to hold the lugs of the mold. To the piston of the cylinder is attached a ram which pushes off the scrap from the mold. If a larger cylinder were to be so arranged and to have brackets as well as arms many mold stickers could be handled. In every Mold Yard there should be kept a supply of gas. This would be splendid when any of the buggies are badly gummed, and it could be used in combination with the ram for stickers. We feel that by this method at least one man could be easily spared from the Mold Yard.

Reduction in the Mixing House.

In one plant the Mixing House crane-man is foreman of the operations. This is an excellent plan for that plant and I feel that it would work out well in most Mixing Houses. He is in direct view of the various parts of the Mixing House and from his post he can see well all operations. As he is in command, when he lowers the buckets into the wells or pits at the side of the cupolas the dolomite shovelers start to work at once. He brings the materials to the pan men, and he keeps in very close touch with his men. Where the coal drying is done in the Mixing House, the coal drier can be eliminated and his work done by the pan men.

Let us see what has been accomplished by these reductions. The force now stands:

Office		Reduction.	(Both Turns)
1 Superintendent, one turn.....	1	..	..
1 Assistant Superintendent, one turn	1	..	..
1 Clerk, one turn.....	1	1	1
1 Timekeeper, one turn.....	1	..	..
4 Total.....	4	1	1

Metal Mixer

1 Mixer Crane-man, two turns.....	2	..	..
1 Mixer Boss, two turns.....	2	..	..
3 Mixer Helpers, two turns.....	6	..	..
.. Ladle Skuller or one Helper.....	1	2	..
5 Total.....	10	1	2

Stock Yard

4 Stock Crane-men, two turns.....	8	..	..
1 Stocker Boss, two turns.....	2	..	..
6 Scrap and Metal Loaders, two turns	12	2	4
2 Ore and Limestone Loaders, two turns	4	2	4
1 Oil Man, two turns.....	2	..	..
1 Buggy Repairman, one turn.....	1	..	..
1 Buggy Repairman Helper, one turn	1	..	..
16 Total.....	30	4	8

Charging Floor

3 Crane-men, two turns.....	6	..	..
2 Melter Foremen, two turns.....	4	..	..
12 First Helpers, two turns.....	24	..	..
16 Second-Third Helpers, two turns.	32	8	16
2 Weighups, two turns.....	4	1	2
6 Pullups, two turns.....	12	2	4
41 Total.....	82	11	22

Pitside

3 Crane-men, two turns.....	6	..	..
1 Pit Boss, two turns.....	2	..	..
2 Steel Pourers, two turns.....	4	..	..
4 Steel Pourers Helpers, two turns.	8	2	4
1 Ladle Liner, one turn.....	1	..	..
1 Ladle Liner Helper, one turn.....	1	1	1
1 Stopper Setter, two turns.....	2	..	..
1 Stopper Setter Helper, two turns..	2	..	..
1 Nozzle Setter, two turns.....	2	..	..
1 Nozzle Setter Helper, two turns..	2	..	..
.. Steel Shipper	1	1	2
1 Ingot Scales Weighup, two turns..	2	..	..
17 Total.....	32	4	7

Mold Yard and Stripper

2 Stripper Crane-men, two turns....	4	..	..
1 Mold Yard Crane-man, two turns..	2	..	..
1 Mold Yard Boss, two turns.....	2	..	..
3 Mold Scrappers, two turns.....	6	1	2
7 Total.....	14	1	2

Mixing House

1 Foreman, two turns.....	2	..	..
.. Crane-man	1	1	2
.. Coal Drier	1	..	2
3 Pan Men, two turns.....	6	..	..
4 Dolomite Shovelers, two turns....	8	..	..
1 Stopper Maker, one turn.....	1	..	..
9 Total.....	17	2	4

Open Hearth General Labor Gang

1 Foreman, one turn.....	1	..	..
12 Laborers, one turn.....	12	..	..
13 Total.....	13	..	..

Millwright Department

1 Millwright, two turns.....	2	..	..
1 Millwright Helper, two turns.....	2	..	..
2 Total.....	4	..	..

Electrical Department

1 Electrical Inspector, two turns...	2	..	..
2 Helpers, two turns.....	4	..	..
3 Total.....	6	..	..

Reductions by Departmental Units

		Both turns.
Office	1	1
Metal Mixer	1	2
Stock Yard	4	8
Charging Floor	11	22
Pitside	4	7
Mold Yard	1	2
Mixing House	2	4
Total Reductions	24	46

Time studies comprise an excellent way to find inefficient arrangement of men.

In making any cuts in force the following rules should apply:

- 1st. Will this cut injure the quality of my steel?
- 2nd. Will it injure my production?
- 3rd. Will it cause the remaining men in that occupation to work harder than I would be willing to work myself in their positions?

4th. Will the wages I will pay these men be commensurate with their increased efficiency?

If these questions can be satisfactorily answered, the issue should be fearlessly pressed.

Steel Company Completes New Additions

The Indiana Rolling Mill Company Makes Additions to Buildings and Equipment—Enlarged Plant to Follow These Improvements.

By A. C. GAYLORD*

THE close of the year 1921 saw the completion of improvements costing approximately \$250,000 at the plant of the Indiana Rolling Mill Company, located at New Castle, Ind. Most of this amount was expended in the rolling mill department.

The company is engaged in the manufacture of two lines of goods, a complete line of shovels and spades and the rolling of high carbon sheet steel.

Most noticeable of these improvements is the new two-story and basement office building located on the hill about 500 feet west of the plant. It is built of reinforced concrete, seal brown Hitex brick, and mottled white and brown terra cotta for trimmings.

It is located high enough to overlook the entire plant and affords an interesting view of the Blue River Valley across to the city of New Castle.

The first floor of the office building is divided into a large general office, five private offices, a ladies' rest room, etc. Only part of the second floor is finished at present, providing one office and drafting room. The basement, which is well lighted, will be used for laboratory and cafeteria.

The power plant has been increased by the addition of a 550-hp. high pressure Springfield water tube boiler and a 1,000-hp. Murray Corliss engine. The boiler is equipped with an automatically controlled Riley stoker and a 6x135 ft. stack. This has been so located that it will be the first of a series of boilers in the completed design. The old boilers are of the Geary water tube type, hand fired and equipped with Coppus blowers.

The new boiler is enclosed in a temporary building, and the coal is delivered to the stoker hopper by means of a 25-ft. Unicon portable belt conveyor, so arranged that it can receive coal directly from the car or from the storage space in front of the boiler, within a radius of 30 ft. This coal elevator enables the fireman to unload the coal from the car into the hopper of the conveyor with less effort than is required to shovel the coal from the floor into the stoker hopper.

*Mr. Gaylord is general superintendent of the Indiana Rolling Mill Company. He is also a member of The Society of Industrial Engineers.

At present the ashes are removed from the ashpit by hand through a tunnel which also serves a gas producer and a Type E furnace stoker.

Plans have been made to erect a new boiler house large enough to accommodate at least two boilers which will be equipped with modern coal and ash handling machinery.

An extension, 120x120 ft., has been added to the main rolling mill building to provide space for the new 28-in. sheet mill. This addition consists of the main span 60 ft. wide and two lean-tos, 27 and 33 ft. wide, respectively. Two steel trusses are spaced 20 ft. centers and the supporting columns also carry the crane track girders. A new 15-ton Milwaukee crane, equipped with 5-ton auxiliary hoist, has been added to the old crane service.

Part of the floor space in this extension is covered with concrete, and a loading platform 26 ft. wide extends along one side of the building. The lighting facilities are excellent and good ventilation is secured by means of mechanically operated windows in monitors.

The 28-in. sheet mill was furnished by the Mesta Machine Company of Pittsburgh, Pa., and consists of herringbone reduction gears, 28-in. pinion stand, 28x48-in. roughing stand and two 28x36-in. finishing stands, one of which can be used as a reducing stand whenever necessary.

The reduction gears are cast steel and reduce the engine speed from 75 rpm to 40 rpm. for the speed of the rolls. The pinions are cast steel and the pinion housings are cast iron. The roughing stand housings are of cast steel and weigh 34,000 pounds each. The rolls are also cast steel. The upper roll is counterbalanced and the screws are operated by a 10-hp. motor. An ingenious steam operating lifting table passes the slab back over the top roll to the roller. The housings of the finishing stands are also of cast steel. The first of these is provided with a removable steam operating tilting table for use when reducing heavy stock, or when cogging down. One operator handles both tables at the same time.

A motor driven hot shear is used to cut up the slab before being passed to the finishing rolls. This shear can be moved to the delivery side of the reducing stand

when the mill is used for cogging down purposes.

The finished sheet is passed through a straightening machine, which reduces it to a perfectly flat sheet. The stock for this mill is heated in a continuous powdered coal burning furnace equipped with water cooled skids and hydraulic pusher. The coal is fed from a concrete



Fig. 1—Interior view of the finishing department.

hopper to a crusher by means of a screw feed. From the crusher it falls into the hopper of the elevator which carries it up and deposits it upon the belt of a magnetic separator which, after extracting "tramp iron," delivers it into a storage bin located over the pulverizer. An Aero pulverizer reduces the coal to the proper fineness and automatically mixes it with sufficient air to secure proper combustion. This mixture is fed into the combustion chamber through cast iron nozzles. These noz-

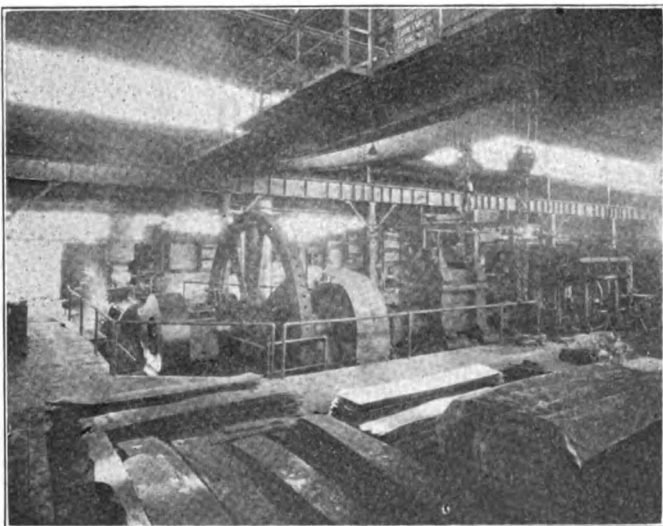


Fig. 2—View of the mill drive.

zles are provided with controlling valves and means for adding auxiliary air from a pressure blower. This air supply can be closely regulated and in the event of the pulverizer being shut down, can be used to keep the heat from entering the supply pipes.

The old plate mill furnace was remodeled by making it continuous and equipped with a Type E stoker. Very

satisfactory results have been obtained since this change was made.

The sheet mill powdered coal furnace has not been in operation long enough to secure comparative data as to the relative merits of the two methods of heating.

This new 28-in. sheet mill is driven by a 30x48-in. Murray Corliss engine, weighing 83,000 pounds exclusive of flywheel and out bearing, which were not furnished by the builders. The sectional flywheel weighs 50,000 pounds and is 20 ft. in diameter. The engine will deliver 940 hp. while operating under a steam pressure of 160 lbs. at one-fourth cut off and 75 rpm. It is equipped with a specially designed safety stop device, suitable for rolling mill service. This new equipment will enable the company to produce high carbon sheets more economically than was possible on the 22-in. mills. Approximately 50 carloads of sand and gravel, 15 carloads of cement and 10 carloads of brick were used in making these improvements.

A large electric caterpillar crane is used to unload slabs and load scrap. This is easily moved about the yard and has some advantages over the railroad type.

Stuebing lift trucks are used to handle and load the finished product. The floors in the shearing department are of concrete and the loading track is depressed sufficiently to allow trucks to enter the cars.

The shearing department is equipped with three 120-inch shears and three Toledo presses. One of the latter weighs over 80,000 pounds and is capable of punching out discs 32 in. in diameter. A number of smaller shears and punches are used in cutting up scrap and for light punching.

PRACTICAL USE OF THE OPTICAL PYROMETER.

The optical pyrometer depends upon the principle, that the brightness of the light-emission of a highly-heated body, bears a known proportion to the temperature of same. In practice, the light emitted, is observed through a filter, which only permits the passage of light of a certain wave-length, and this beam is compared with that of a filament lamp of known intensity. The brightness of radiation from the lamp is then regulated until it agrees with that emitted from the body under observation. The amount of such regulation shows the brightness of the body, and, with suitable corrections, a close proximity to its temperature.

Optical pyrometers are of two kinds, broadly speaking. (1) The Wanner, using polarized light observed through a Nicol, by rotating which, the brightness can be altered, the amount of rotation necessary determining the relative brightness. (2) The Holborn-Kurlbaum, wherein the brightness of the filament lamp is altered by resistance. With this instrument, the strength of current necessary to produce brightness in the lamp, equal to that of the observed body, supplies the measure of relative brightness.

In the first case, one only sees the polarized light from the object under examination, but with the second instrument, the object itself, also the surroundings, are seen, but, owing to the telescope, reversed. At the same time, one also sees the glowing filament, the image of which is caused to fall upon the image of the body. The resistance is then regulated until the former merges indistinguishable into the latter, i. e., until the brightness of each is identical.

Recent Development In European By-Product Coking

A Series of Articles Dealing with the Various Types of Electric Gas Governors Which Have Been Introduced in Europe.

By A. THAW

PART II.

IN the first of my series of articles appearing in the March issue of THE BLAST FURNACE AND STEEL PLANT, the governor manufactured by Kress, a coke works manager, was described. We will follow up this month by describing the other principal styles of electric governors brought out in Europe during the past few years.

Governor by Allgemeine Vergasungs-Gesellschaft, Berlin.

This governor is shown in Fig. 5 diagrammatically. The receiver for the pressure variations consists of a single bell *a*, floating in a vessel partly filled with water or oil and connected by a steel band with counterweight

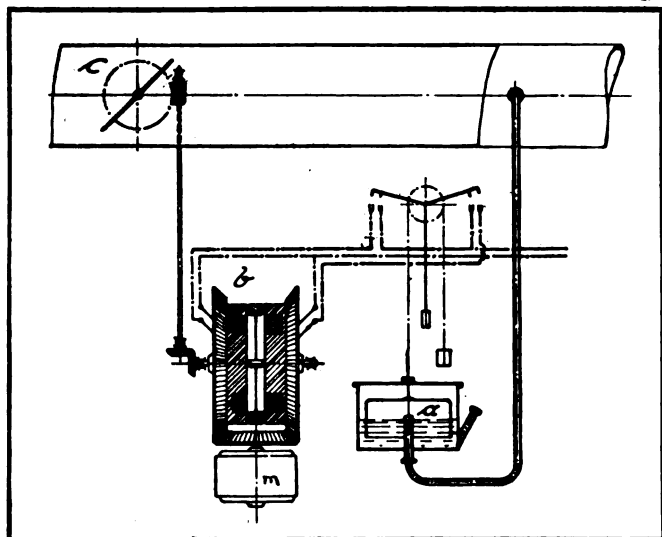


Fig. 5—Diagrammatical view of governor arrangement by Allgemeine Vergasungs-Gesellschaft of Berlin.

to a shaft to which finger-like two contacts are fixed. The cables lead to the regulating device consisting of a mechanically operated magnetic reversing clutch *b*, driven by a little motor *m* running permanently in the same direction and connected by means of a worm gear to the butterfly valve *c* in the gas main, serving as a regulating medium.

The motor is geared to the two bevel wheels of the clutch and turns them permanently in opposite direction to each other, loosely running on their shaft. The latter—being on one end geared to the worm drive of the butterfly valve *c*, carries in the middle between the two bevel wheels a friction wheel fixed by a key to the shaft. The two loosely running bevel wheels are provided on their inside planes with electro magnets and depending upon which the gear wheel is turned a corresponding

number of times and the valve *c* is adjusted accordingly. In a still later construction the magnets are carried by two wheels keyed to the shaft back to back, each facing one of the bevel wheels. While the arrangement is closely drawn together in Fig. 5, there may, of course, be an unlimited distance between the receiver and the adjusting device. The advantage of this arrangement compared with the former is obvious in that the movement stops immediately after the circuit is broken, as the speed of the reversing clutch is comparatively slow.

In all cases of butterfly valves being employed as a regulating medium for large diameter gas mains, the application of a worm gear becomes compulsory, as otherwise the flow of the gas will alter the position of the valve disc on its own account.

Governor by Reineke.

The latest design in this connection is the governor by Reineke, being shown diagrammatically in Fig. 6. The adjusting arrangement is influenced by two little motors of $\frac{1}{4}$ - $\frac{1}{2}$ hp. each. They also operate a reversing gear which, however, does not act upon electromagnets, but works mechanically, its principle being based upon certain well known physical laws. The shafts of the motors I and II are rigidly connected to the two bevel wheels Z2 which are running loosely on the short shaft B. The latter is fixed to the ring A and this ring A is again fastened to the bevel wheel Z3, which can revolve freely on the shaft of the motor I. The bevel wheel Z3 is in gear with the bevel wheel Z3A, which is directly connected to the butterfly valve serving as a regulating medium.

The regulating action can be described as follows: The ac. motors I and II run normally at the same speed in opposite direction to each other, driving at the same time two bevel wheels Z2 which run in this case loosely on their shaft B without turning it. Thus the bevel wheel Z3 and at the same time the butterfly valve remain stationary. To move the latter in both directions, it becomes necessary that for a corresponding time the speed of the motors varies from each other and to cause the variations of gas pressure to effect this, a mercury contact arrangement is provided, influenced by a floating bell D connected to the gas main by a pipe. If, for instance, the gas pressure increases, the rotor resistance F remains short circuited while the contacts E1 leave the mercury, bringing the rotor resistance F1 into circuit so that the number of revolutions of the motor I becomes less than of motor II.

As now the number of revolutions of the bevel wheel on motor I is different to the bevel wheel driven by

motor II, the bevel wheels Z2 are compelled to revolve not only around their own shaft, but also corresponding to the difference of revolutions with a certain speed and direction around the shaft of the bevel wheels Z1. If the gas pressure decreases and the contact lever C is lowered, dipping into the mercury contact, so is thereby the speed of the motor II reduced (motor I running normal) and the bevel wheels Z2 travel in opposite di-

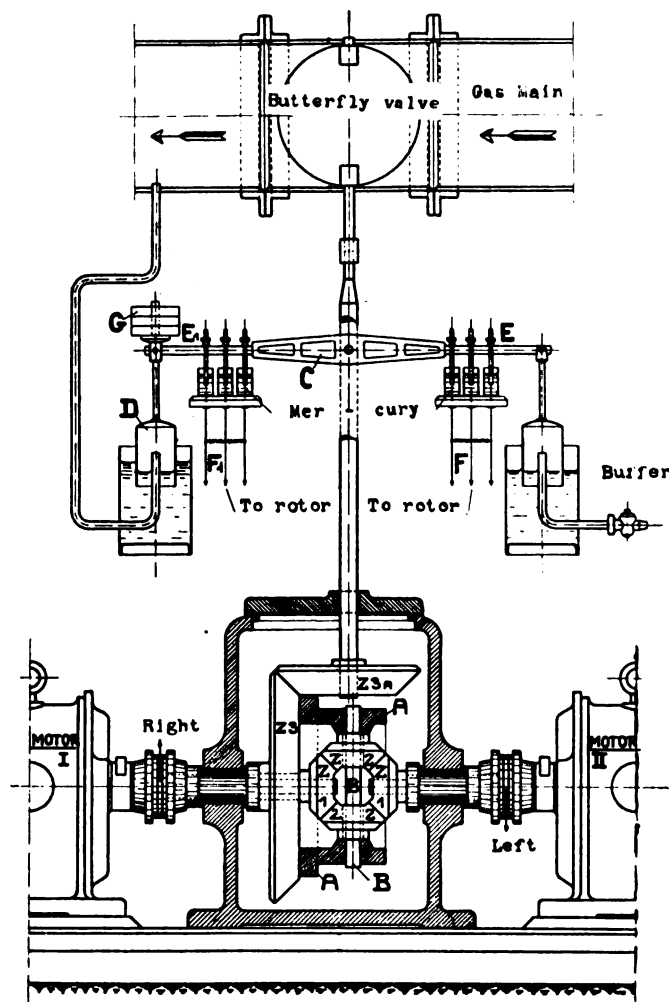


Fig. 6—Governor arrangement by Reineke.

rection around the bevel wheels Z1. By means of this travel, the bevel wheel Z3 is turned and consequently the butterfly valve is adjusted correspondingly and moved along until the gas pressure and the weight of the bell balance themselves again. The contact lever then remains in the horizontal position, as shown in Fig. 6, and both motors revolve at the same speed, both rotor circuits being short circuited. For adjusting the arrangement in any desired condition, the floating bell D carries a weight C consisting of a variable number of plates. On the opposite end of the contact lever C, a second float may be arranged as shown, serving as an air buffer by the space underneath this bell being connected to the atmosphere by means of a pipe with adjustable cock. This arrangement prevents an action of the apparatus in case of minute pressure waves. The governor by Reineke, though of quite recent design, has been adopted by a great number of works dealing with large volumes of gas and it has well justified its claims.

Governor by Simon-Carves, Manchester.

Simon-Carves of Manchester, England, have brought

out a new type of electric governor in which electro-motors are altogether dispensed with. The arrangement is shown in the diagrammatical sketch in Fig. 7 and will be briefly described. A bell *a* floats in an oil seal *b* over the end of a branch *c* from the gas main *d*. The bell is connected to one arm *e1* by a rocking lever *e* and the other arm *e2* of the lever is connected to one terminal of a battery *f* and is adapted to co-act with a pair of contacts *g, h*, to complete the circuit through one or other of a pair of solenoids *j, k*, which are connected to the other terminal of the battery *f*, in parallel, and to the contacts *g, h*, respectively. The solenoids *j, k*, are provided with cores *j1, k1*, connected by wires *j2, k2*, to the arms of a double armed quadrant *m*, which in turn is connected by link *n* and lever *o* to a valve *p* situated in the passage *q* through which the gas is drawn off from the main *d* by the exhausters.

Normally the arm *e2* of the lever *e* does not engage either of the contacts *g, h*, neither solenoid is energized, and the valve *p* is partially open to a predetermined extent. In the event of the generation of gas in the ovens and the pressure in the main *d* falling below normal, the bell *a* falls and rocks the lever *e* to cause the arm *e2* to engage the contact *g* and close the circuit through the solenoid *j*. On the energizing of this solenoid its core *j1* is pulled down and operates the quadrant *m* into the position indicated in dotted lines, which through the link *n* and the lever *o* partially closes the valve *p*, thus reducing the effective area of the passage *q*. If, on the other hand, the generation of gas and pressure in the main *d* should rise above the normal, the bell *a* rises and operates the rocking lever *e* so that its arm *e2* engages the contact *h* and completes the circuit through the solenoid

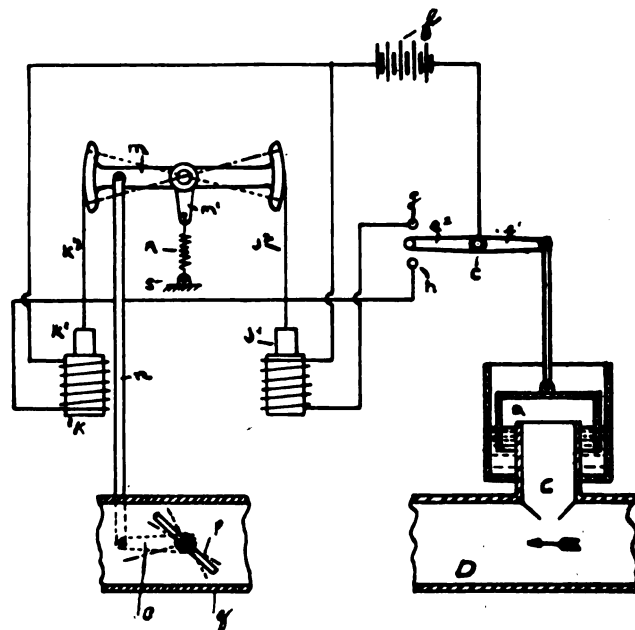


Fig. 7—Diagrammatical view of governor arrangement by Simon-Carves.

k. The core *k1* of this solenoid is then pulled down and operates the quadrant *m* into the position indicated in dotted lines to further open the valve *p*, to increase the effective area of the passage *q* until the pressure in the main again reaches the normal.

The valve is loaded by a weight, spring or other means so that when the circuits through both solenoids are broken, either on normal conditions again obtaining after the valve has been partially closed or further

opened, or in case of failure, the valve assumes its normal partially open position. Generally the quadrant *m* is fixed like shown in Fig. 7, with a central arm *ml*, to which is connected one end of a spring *r*, which has its other end connected to a fixed point *s* and which brings the quadrant and at the same time the valve to normal position when the circuits through both solenoids are open.

Governor by Bamag, Berlin.

A comparatively simple device for adjusting the pressure of clean gas, particularly high pressure gas, at very distant points of delivery is shown in Figs. 8 and 9. The receiver connected to the gas main near the point of delivery is shown in Fig. 9 in section and consists of a cup-shaped receptacle flanged together in the middle and holding a metal disc diaphragm which by a vertical rod in center acts upon a balance lever carrying on one end a counterweight and playing with the other between two electric contacts. In the bottom of the receptacle is a gas inlet connected to the gas main so that the pressure of the gas acts upon the diaphragm and by its movements gives contact with the end of the balance lever. The contacts are connected to a few electric cells or a low tension battery and by wires to a contact arrangement of the governor, which is placed in the gas main near the works. The governor is shown in section in Fig. 9, being a direct acting device operated by the gas pressure, which influences a diaphragm. This arrangement offers the advantage that compared with the older types no attention is required to keep the water, in which a bell flows at a certain level and in addition renders the arrangement by the absence of water unaffected from frost. The center of the disc, serving as a diaphragm, is connected to a vertical rod holding on its lower end a valve, sliding in a seat placed into the main gas passage. The gas pressure underneath the diaphragm is adjusted by a special valve operated by two electromagnets which are influenced from the receiver shown in Fig. 8. Thus if the pressure on the point of delivery increases, the receiver makes contact and transmitting a corresponding contact to the governor causes by the action of the valve, operated by the electro magnets, the pressure under the diaphragm to be increased and the foot valve thereby to be raised proportionately. If the pressure drops at the point of delivery, the pressure under the diaphragm is also caused to drop by the same means and the foot valve is correspondingly opened. At the moment the electric circuit is broken,

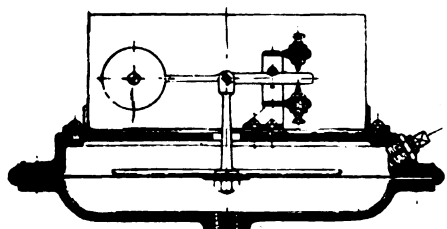


Fig. 8—Diaphragm receiver to governor by Bamag of Berlin.

the valve spindle readjusts the steering lever automatically to its normal position, while in closing the circuit the contact is broken again in the one or the other direction by means of an electro magnet so that the lever can play freely.

The sensitive electric portion of the governor is protected by a casing with glass window and locked to prevent strangers from tampering with it. The effect of the foot valve can be altered within wide limits by turning the valve piston by means of the handle seen under the

bottom of the governor in Fig. 9. For this purpose the valve piston is provided with two wings, and the valve seat with two corresponding port holes, the area of each representing the fourth part of a circle. By turning the valve piston with the handle, the port holes can be opened or closed altogether and the capacity of the governor varied within wide limits. This additional feature is of particular importance for those works on which the

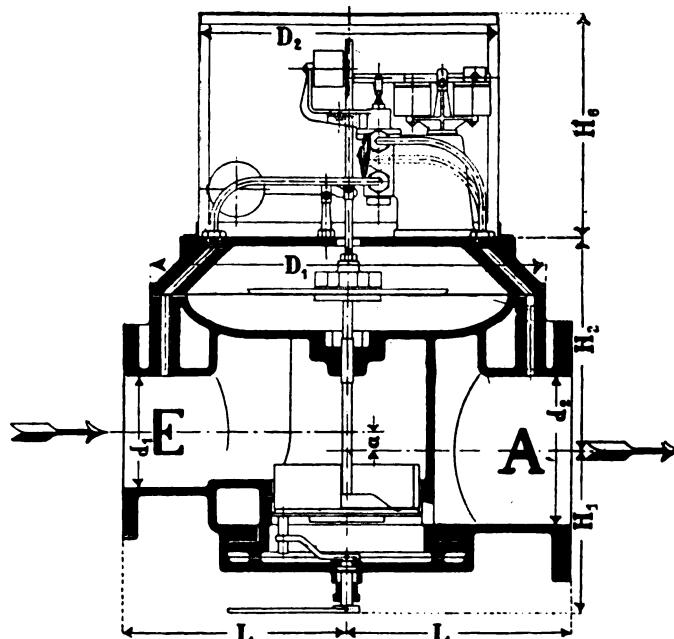


Fig. 9—Governor by Bamag of Berlin.

volumes sent through the mains vary at times considerably while the pressure conditions are to remain constant irrespective of the load. It also enables the same governor to be used on works which expect a considerable increase of gas deliveries gradually or in time to come. In both diaphragm casings, of the receiver as well as of the governor, the air escaped through a plug with a needle-fine opening. This slow escape and entrance of air serves at the same time as a buffer to the movements of the diaphragms and of the valve rod.

While the writer is particularly connected with by-product coke ovens, where electric governors have come to stay, they have in no small measure also helped to ease considerably the operations of blast furnace, producer and steel plants and have been largely introduced to all kinds of works handling large volumes of gas.

STATEMENT OF OWNERSHIP, MANAGEMENT, ETC., OF

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(My commission expires March 9, 1923.)

Selection and Heat Treatment of Tool Steel

In the Selection of the Proper Steel for a Tool There Are Various Intricate Factors to Be Considered.

By S. C. SPAULDING
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TOOL steel as its name implies is steel adapted for the making of tools. The determining points of its adaptability are capability of fabricating, machining, forging, pressing, etc., and possibility of safely hardening or suitably heat treating to put it in condition for use. Of the two points the latter is the most important as we can afford some extra trouble or expense in fabrication if greater safety in hardening or better production from the hardened tool is obtained.

In the early days the problem was simple. There was only one kind of steel, the straight carbon from which to make all tools. The hardener did not need to worry about whether it was a tungsten steel or a vanadium steel requiring special handling in heating and quenching. As long as the proper carbon content had been selected he merely need bring it to the proper temperature, quench in water or brine, draw back the temper for the service required and all was well. This simple carbon tool steel ranging from 0.60 to 1.25 carbon is still widely and rightly used today for many tools. It is only where special requirements of speed, service, or duty are needed that the special tool steels are economical. It is often said that this is an age of specialization for every need a definite prescription. In the last few years many special tool steels have been developed and in the near future there can be no doubt that many new and seemingly revolutionary steels will be in use.

In selection of the proper steel for a tool there are certain factors to be considered.

(1) The amount and intricateness of machining to be done on it. If much stock is to be removed and complicated shapes to be cut it must machine readily. If we merely need to drill a hole in it ease of machining is not so important.

(2) Can the tool be readily ground to size after hardening or must it come through the hardening with minimum change in shape?

(3) Is it going to be easy or difficult to harden without breakage.

(4) Will it have steady cutting, have light shock or will it be subjected to heavy blows? Is it to do heavy duty work, removing maximum metal in minimum time or is the amount of metal to be removed small but the finish obtained on the piece important?

(5) The kind of material to be cut, metal, wood, fiber, paper, felt, etc.

(6) Will it operate on cold or hot metal?

(7) Is it to make only one or two pieces or must it turn out great numbers of the same kind of parts?

In regards the first point, practically any of the

ordinary carbon, alloy, or high speed steels can be annealed to machine readily and under proper handling easily and safely forged. For some special purposes however as in fine wire drawing dies where only a simple hole need be pierced in them ease of machining is of secondary importance and special steels are used which even in the annealed state are hard and are not capable of ready machining.

Considering the second factor in selection. In hardening steel expands, becomes less dense or in other words the same piece of steel after hardening is larger, takes up more room than it did before. Now as this hardened piece is tempered or drawn it contracts and at some certain temperature it will come back to its original density or occupy the same space as it did before hardening. If however it is necessary to heat it or draw it to so high a temperature that it becomes soft before it returns to its original size, as a tool it has become useless. The carbon tool steels were all found to be subject to this disadvantage. Where the tool was a simple one it could easily be ground to the required shape after hardening and warpage was not harmful. Where however the shape was complicated grinding was not always possible and lapping very expensive. You can readily realize for instance that fine thread gages where accuracy is vital would be prohibitively expensive if made from a steel which expanded so much in hardening that much metal must be removed by lapping. Again many dies are so intricate that they must be built up in sections which fit accurately together. If after hardening these sections are all out of shape much expensive grinding and lapping must be done. In the early days of manufacturing things were on a small scale and intricate dies not so common. As modern American production methods came into vogue larger and more complicated tools were designed and to meet these requirements the steel men developed an oil hardening non-changeable tool and die steel. This steel hardens very deeply and though it has a normal expansion on hardening when drawn at a low temperature before any softening occurs it returns to its original size and shape. Since its introduction it has had a wide and wonderful use saving annually thousands of hours of otherwise necessary grinding and lapping. I consider the development of this steel one of the great accomplishments of modern metallurgy.

The third factor that of probability of breakage in hardening would if carefully considered by the tool designer and metallurgist who selects the steel save large amounts of money by preventing unnecessary breakage. Of course it is necessary in many tools to

have keyways, sharp angles, abrupt changes of section, but many times their effect could be ameliorated by the generous use of fillets. There has been an encouraging tendency of late to recognize the danger of sharp corners and in place of the old square keyway we find most of the large tool manufacturers using the half round keyway having no corners. This change came as an economic necessity. When the production of tools in large quantities was attempted tools had to be hardened by large scale production methods, a particularly delicate one could not be picked out and nursed by an expert man. They were all put through together on an accurately determined time temperature basis and with the old square keyway the losses from breakage became prohibitively large. The large manufacturer thus found that as a matter of self preservation he must give careful thought in designing a tool to the elimination of all possible causes of breakage. Another very frequent cause for breakage is abrupt change of section thin to thick or thick to thin. Often it is impossible to change the design to eliminate breakage risk and again it is necessary to go to the same oil hardening non-changeable steel, as tools would invariably crack if of water hardening tool steel.

The fourth consideration that of the duty required of the steel is of prime importance in its selection for the tool. Steels which are made for heavy roughing or hogging cuts are not suitable for light finishing cuts. In removing a heavy chip at high speed the metal is pushed and torn off. The extreme edge of the tool does not have or need a keen edge. The work of the tool falls on an area just back of the cutting edge where the pressure of the chip comes. The tool will keep on cutting until the heat generated by this chip friction becomes so great that the nose gives way and the tool ceases to cut. Hence for this work the problem is to select a steel having maximum heat resisting powers, that is one which has the maximum resistance to softening under the operating heat. The tool should then be designed so as to have maximum heat conduction as the faster the heat is conducted away from the cutting edge the more work it will stand before breaking down. For these fields two typical high speed steels have been developed. One all around type which stands much heavy work yet when properly shaped and with light cuts will produce good finish, and hold a fair edge. The other type has greater heat resisting powers, will stand up to heavier cuts and on harder material but will not hold as good a finishing edge. For the small shop doing miscellaneous work the first type will be the best. The other is a specialty steel to be adapted to particular jobs. There are other tools where ability to remove large amounts of metal is unimportant, the main consideration being the taking of a keen edge and producing a good finish on the work. For this purpose the straight carbon or semi-high speed finishing steels are adapted. The manner of using the tool should receive important consideration. If it is to have great shock like a hammer die it must have a tough cushion interior to keep it from flying to pieces. Tool designers thinking only of the hardness feature have put high speed steel into hammer dies only to see them fly to pieces on the first blow, it is well to remember that a tool to resist great and repeated shocks must have toughness. Where this shock factor is absent we can make our selection by its cutting or working powers but where repeated heavy shock is present that must

be the governing factor as we might select a steel to give us the hardest and densest die in the world yet if it flew to pieces at the start it would never be of much use to us.

The kind of material to be cut is a vital factor. The steel which does good work cutting steel does not always do so well in cutting brass, wood, fiber, felt, etc. For cutting felt or paper a very keen edge is necessary and the high speed steel made for roughing work would not be in the running with a high carbon straight carbon tool steel. Wood working tools for machine use must stand heat as they run at very high speeds yet the regular high speed steel would not do as though it might stand the heating it would be too brittle and break under the shock of striking a knot or perhaps a nail or spike without breaking or dulling the cutting edge.

Considering the sixth point, I may say at the start by hot metal I mean metal at least a red heat. When a tool works on hot metal it naturally absorbs some of the heat and in order for it to stand up it must exhibit resistance to wear when hot. Plain carbon steels do not exhibit this property to any great extent and we must turn to a special type of steel. During the late war until a hot work steel suitable for piercing shells was developed the production of this type of shells suffered for lack of piercing tools. Other jobs where special hot work steels prove their worth are, hot bolt and nut machines, riveting, hot shears, etc.

The last factor is one of economy rather than suitability of the steel for the tool. For instance, suppose we are making a punch and die for blanking out parts of which we need hundreds of thousands or millions, numbers beyond the possible production of any one die. The cost of the material of which we make the die is negligible compared with the advantage of increased production. We will therefore use the steel best suited to give the greatest production regardless of its cost. On the other hand if we are to make only one or two pieces with a tool it will not pay to use an expensive steel which is capable of high production where a cheap grade will make as many as we need.

This covers the salient factors to be considered in the selection of a steel for a tool. Careful consideration of them by metallurgists and tool designers or others who are to specify what goes into a tool would prevent many costly tool failures. Make it a rule to consider these points as the first step in designing a tool and if an uncertainty comes up consult the steel man before it is too late so that he can help you to make a perfectly designed, easy hardening high production tool.

Turning now to the heat treatment of the tool. Very few tools are useful in the condition in which they leave the tool makers hands. They almost always require hardening or toughening to some degree. This is accomplished by heat treatment. The usual procedure may be outlined as follows. First, heat to some definite temperature. Second, remove from the heating medium and cool in some manner. Third, reheat to some definite temperature to remove brittleness and produce the required degree of hardness and toughness.

To accomplish the first step we must have a means for heating. There are many ways of applying heat, from an open gas burner, blow torch, coal forge, gas or oil fired furnace to the most refined accurately controlled electrically heated furnace. To select the

proper medium let us first consider what goes on when a piece of steel is heated. As the steel absorbs heat it gradually expands that is becomes longer and wider and thicker. As the heat increases this expansion increases at a definite and uniform rate until a point called the decalescent or critical point will be reached. As heat continues to be applied beyond this point the rate of expansion suffers a very great and sudden change. In fact the steel begins to contract. Now as the heat is increased beyond this point the steel commences to expand once more but at a much more rapid rate as shown by the increased steepness of the portion of the curve beyond C. **The steel expands first slowly then contracts then expands rapidly.** Suppose it is heating at a very rapid rate, the corners and the small projections getting hot much sooner than the main body, they must have expanded then contracted then expanded very rapidly just at the time perhaps when the main body to which they are attached was starting to contract. We easily see then that very severe and unequal strains have been set up in our tool and after we quench and temper it we will doubtless find a corner or small projection missing, or the piece may hold together but be badly warped requiring excessive and unnecessary expense for grinding and straightening. Suppose we place the tool in a furnace which though it may not heat rapidly is not of a uniform temperature at all points, then one portion of our tool will always be at a different temperature than another and the same strains set up as in rapid heating. We will draw the conclusion then that the tool must be heated slowly and uniformly if we wish to minimize warpage and breakage.

Having considered the effect of heating a piece of steel and obtained some conception of the ideal heating cycle let us inquire into the means at hand for carrying this process out. Heating devices are wide in number and in variety of design but few are fit for the work. The oldest and one of the simplest methods is the charcoal fire or coal forge. Here rate of heating and uniformity of heating are all a matter of skill and judgment. There is no fixed point to go by, the man simply heaps up a fire and works it down to get the conditions as he wants them. It is impossible in the forge to exactly duplicate conditions and the smith will turn out some wonderfully good and some woefully bad tools. If the fire is made very large it is hard to keep all parts at the same heat. The best chances for good work are with a small fire and small tools, yet I have seen shops where large and complicated pieces were hardened in a forge fire usually to the detriment of the piece. Another more modern but more to be condemned method is the gas torch you will find in many tool rooms. While it has its place in straightening, melting lead, etc., it is not suitable for tool hardening. Yet you will see a tool maker attempt to heat a fairly good sized piece in it for hardening. The result is nearly always poor. One side is blistered and decarburized while the other side is cold and if he gets it through without cracking it will have soft spots.

To turn to heating devices in which we at least have a possibility of carrying out our process in the proper manner we find electric, gas, oil, and coal fired muffle and semi-muffle furnaces. Full muffle furnaces are seldom used. The usual medium is the semi-muffle where the hot gases of combustion come in contact with the work to be heated. Electric furnaces have not a wide use in tool hardening due to their

greater cost although they make an ideal heating medium. Gas is most used in tool rooms and small shops due to its flexibility and simplicity of installation, ease of control and absence of dirt. Oil is used in large plants where the number of furnaces in operation justifies the expense of installing pumps and tanks to utilize its cheaper cost. Coal is not suitable for a small furnace but may be used to heat large heat treating furnaces. As we have said that semi-muffle furnaces in which the gases of combustion come in contact with the steel being heated are usually used, the effect these gases may have on our tool becomes important. Free oxygen or carbon dioxide in the gases will combine with the carbon in the steel removing it first from the surface then deeper and deeper until we get a decarburized layer of appreciable depth which will not harden and spoils the tool unless it can be removed by grinding. Oxygen also reacts with the iron in the steel to form an oxide scale while carbon dioxide reacts only with the carbon and leaves no scale. A small amount of oxygen in the furnace gases is preferable to carbon dioxide as its action on carbon and iron forms a scale over the surface which on quenching in water will fall off leaving a hard finish. Carbon dioxide in the gases is more to be feared as it does not show its presence by scale formation and though the tool comes out of the quench perfectly clean looking it will have a soft surface of decarburized iron. The safest way is to so control our furnace atmosphere that we have neither free oxygen nor carbon dioxide present but have our gases all carbon monoxide as this gas will not react with a clean piece of steel. If the piece be coated with scale however from a previous oxidizing atmosphere the carbon monoxide will reduce this scale to iron and again we will have a soft surface on our quenched tool. The customary way of obtaining a reducing or carbon monoxide atmosphere is to supply insufficient air for complete combustion of our fuel. This is sometimes known as running with a smoky flame. Excessive sulphur in the fuel will cause a soft surface on our hardened piece but this trouble is seldom met with. The above applies to heating in semi-muffle furnaces or so called open fire hardening. Another process finding extensive use for many purposes is bath heating. Here a pot is filled with lead or a salt and heated in a specially adapted furnace till it is molten and brought up to the required temperature. Lead is the most used medium. However special salts and cyanide find wide use. In the use of a bath we have to guard against too rapid heating. A piece immersed in a bath at the hardening temperature comes up to heat in a few minutes as the heating is by direct conduction. Such a quick application of heat is not the best thing for a tool steel and where hardening baths are used a preheating bath or furnace should be provided so that in the final heat we only have to raise the temperature a few hundred degrees, as a general rule we might say that bath heating is best applied only to small and simply shaped pieces or where only local hardening is desired.

Having briefly covered the methods of heating we will turn to the next operation, that of cooling the heated piece. There are as many cooling mediums as there are liquids but only four that have any wide use. These in order of their speed of cooling with the most rapid are, first, brine, water, oil, air. Brine is useful where extreme hardness is desired and particularly where we do not have a circulating system.

Where we have a copious supply of cool clear water under pressure piped to our quenching tank brine is not necessary. Where however we merely have a tank with no inlet or outlet brine is to be preferred as it will give a more drastic quench than still water and its quenching powers will not fall so rapidly with rise in temperature. Oil at the start of the quench cools the piece almost as rapidly as water. The cooling rate quickly falls off however and as we get down around 800 deg. F. and below the rate is very slow. A water hardening steel unless in very small section will soften under this slow cooling. It is only certain of the tool steels which have been especially designed for it that will harden when quenched in oil. In the tool steel line oil quenching finds its greatest use in the hardening of high speed steel. Air is the slowest of the quenches and is used only occasionally for high speed and air hardening steels. The air is usually supplied as a blast which is applied to the nose of the tool. An objection to air quenching is the heavy scale that is formed. Special quenching mediums which might be mentioned are molten lead and salts usually at a temperature of 1,000 deg. to 1,100 deg. F. for quenching high speed steel. There is less liability of cracking and warping when this quench is used and the steel gets just as hard as when quenched in oil. A quench in a hot bath at 1,100 is not equivalent to a quench in oil and draw to 1,100. After a quench in a hot bath the tool should be removed, let cool down to atmosphere and reheated to 1,100 for drawing. Before leaving the subject of quenching I must say that in quenching as in heating uniformity is the watchword. More pieces are cracked from the quench being as you might say not drastic enough than from having too great a flow and pressure of water. Where our circulation is feeble and uncertain we may get a flow of water against one part and still water at others. This condition is likely to result in warpage and breakage. Have a copious supply under good pressure and our inlets so arranged as to give a uniform flow all around the piece and best results will be obtained.

The final operation in hardening of a tool is drawing or tempering. This consists in reheating to some point below where appreciable softening results but high enough so that the strains from hardening will be relieved and consequent brittleness taken out. A tool which has not been drawn will fly to pieces under the least shock whereas the same piece after drawing to the proper heat will stand considerable shock and still be just as hard after drawing as before. There are various methods of accomplishing this reheating or drawing. It may be done by the use of baths as oil, in sand on a hot plate, in front of a furnace door, by a torch or flame, or by heat left in the piece itself. The last method might in some respects seem the best but in practice is good only for small and simply shaped pieces. Where the piece is large or of intricate shape it is impossible to get all parts drawn uniformly from heat left in it. I have seen many times cubical or rectangular hammer dies, the face of which have been chilled and enough heat left in the back to gradually bring the face up to a tempering heat drawn by this method. It is not to be recommended because if the piece is of any size uniform drawing is impossible. The center part of the face gets hot first and although the hardener puts wet swabs on it in an attempt to hold it back till the ends and corners catch up he is never entirely successful. The piece should be cooled down further in the quench so that there is only enough heat

left in it to slowly dry itself off then reheated for the draw. This is many times done on a hot plate or in front of a furnace door. This method is applicable where we want a soft back and a hard face but will not work where we want uniformity of draw in all parts. A piece which has been drawn on a hot plate from the back up will show a steady gradation of hardness from the face down. If it is a die which is to be used many times over by grinding off the face we will get in trouble for as we grind off we get into softer and softer metal. For uniform drawing a bath in which the tool can be immersed or a low temperature oven is the only method. For a bath oil is used up to 550 deg. F. and molten lead and salt mixtures above this. Drawing ovens are usually heated by gas or electricity. The great majority of tools exclusive of high speed are drawn at 375 deg. F. and under, only when extreme hardness is not necessary do we go higher, where toughness and not great hardness is desired we go to 450 deg. F. and sometimes 500 deg. F. Drawing is a progressive phenomena and time at temperature is a vital consideration. In all the above I consider the piece to be held thirty minutes at heat. Thirty minutes has been found to be sufficient time so that a rather stable condition has been reached. This means that the same result will be reached in thirty as in forty, fifty or twenty-five minutes, whereas if we drew our piece for only five minutes increase or decrease of a few minutes would have a marked effect. If a piece be held several hours at heat more effect may be produced than in thirty minutes but for all practical purposes thirty minutes is ample time. Another great advantage of the bath or oven is that a thermometer or other temperature measuring device will give us an accurate indication of the temperature obtained. When drawing on a plate or other simple heat we have no indication of the temperature but the color it assumes at certain heats. This is an inaccurate indication as all steels do not take the same colors at the same temperatures and the condition of the surface and the kind of light effect the color. What will appear as a light straw color by artificial light will be no color at all by day light. A disadvantage of the oven heater as compared with the bath is the impossibility of telling just how long it takes different sized pieces to become heated through. At the low temperatures used for drawing it doubtless takes several hours to thoroughly heat a large piece in an oven whereas in a bath where the piece is totally immersed it becomes heated quickly and the size makes very little difference provided the bath is large enough to contain it. An advantage of the oven is cleanliness. In either type care must be taken not to have the steel being drawn touch the bottom or sides of the container.

NEW HIGH RECORD

The blast furnace of Weirton Steel Co., Weirton, W. Va., on March 15, established a new high record for one day's production of pig iron from one furnace when it tapped 845.6 gross tons of pig iron. This is the second record made in a week by this furnace which on March 9, produced 826.1 gross tons, thus surpassing the former production mark previously held by No. 1 furnace, Pittsburgh Steel Co., Monessen, Pa. In the first 15 days of March the furnace of Weirton Steel Co. produced 11,105.3 gross tons, an average of 740.35 gross tons per day.

New Reversing Valves for Open Hearth Furnaces

A New Construction of a Bell Valve Is Described, Consisting of Two Parts Which Are Separated by Water Cooled Partition Wall—Many Disadvantages of Regular Type Valves Are Overcome.

By HUBERT HERMANN

THE simplest and even today most commonly used valve construction for open hearth furnaces is the simple cylinder valve, a hollow, cylindrical and at the lower end open body with built-in partition, which keeps the gas current airtight against the outside by means of a water seal.

A disadvantage in this simple but efficient construction lies principally in the partition wall, which, under the influence of the hot gases, is destroyed in a com-

paring this valve, the main point was to protect the partition walls from the destroying influences of the hot gases and on the other hand to construct the valve in such a way that the partition walls can be inspected even during the time the furnace is in operation. The valve is made in two halves and connected in such a way that between the two inner walls serving as partition walls, an air space is kept, allowing observation and inspection of the partition walls even during the operation of the furnace. Through this space cooling water can be admitted, thus practically omitting the danger of demolishing the partition. To prevent the water vapors from entering the combustion chamber, an angular ring made of cast iron is inserted on the inside of the water seal, whereby the water surface is covered. The cooling water is admitted by means of two tubes. The water vapors coming from the water seal keep the water in constant circulation between the inside of the cylinder and the cylinder cover. Even the web of the cast iron ring is protected by the cooling water against the damaging influence of the hot gases.

Fig. 1 shows the outside view and Figs. 2 and 3 cross

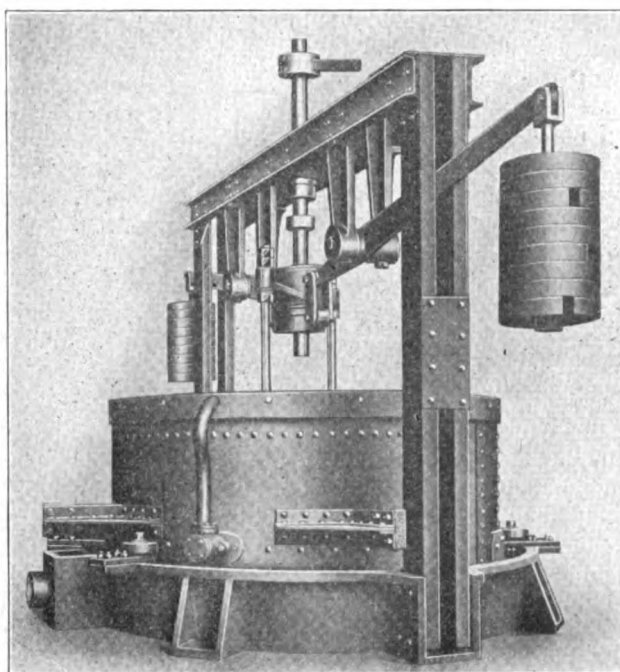


Fig. 1.

paratively short time, therefore necessitating the repair or complete change of the valve. The valve can only be inspected during shutdowns of the furnace and it happens therefore quite frequently that the valve is used in a defective condition. This results in heat losses, increase in working time and lower production. Another disadvantage of this bell valve of the usual design is the way in which the valve is made airtight. Under the constant influence of the hot gases, the water evaporates in large quantities and enters the furnace with the gases, resulting in larger quantities of slag and other drawbacks to operation.

A new cylinder valve, in which the above mentioned disadvantages are eliminated, is made by the Mannstaedter-Works A. G. at Troisdorf near Cologne. In

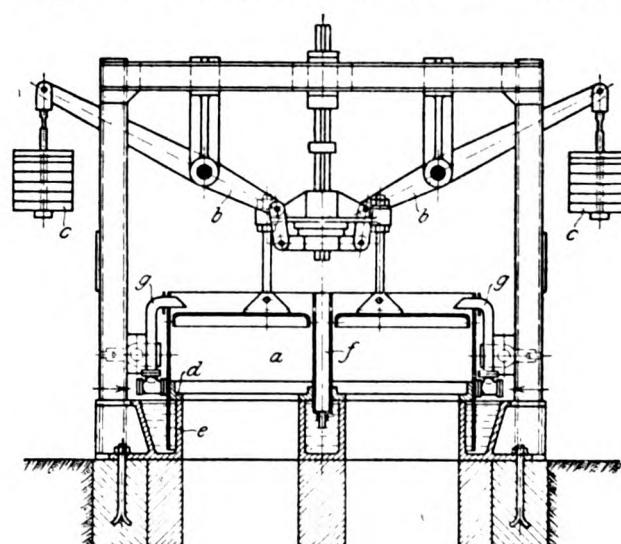


Fig. 2.

section and top view of one of the hand-operated valves, built according to the above specifications.

The cylinder *a* (Figs. 2 and 3) hangs on levers *b* with counterweights *c*. The cast iron ring *d* lies in position on the inside wall *e* of the water seal, thus separating the water seal from the gas chamber. The middle partition *f* consists of two parallel iron plates between which the cooling water flows through pipes *g* and then

into the water seal. While turning, the cylinder is guided by guiding rolls *h*.

Another remarkable feature is the Mannstaedter gas reversing valve, operated automatically. The valve seat has an inside diameter of 26 inches. The cast iron valve plate is hanging on a rod, which is held by a cable of

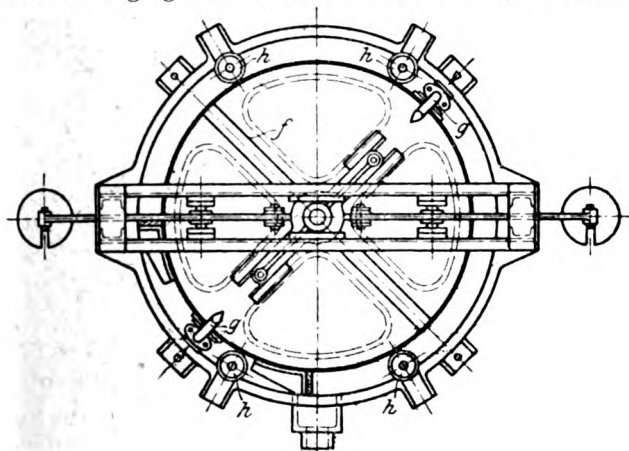


Fig. 3.

$\frac{1}{2}$ -in. diameter. The valve body, made of sheet steel, has a cast iron cover, through which the valve rod passes by means of a split stuffing box and a split gland. The explosion door, arranged on the side, is of the usual construction. To equalize the weight of the valve plate, a lever with counterweight is provided.

The connection with the valve described is effected in such a way that the cable, running over a roll, shuts down the gas valve automatically as soon as the bell is

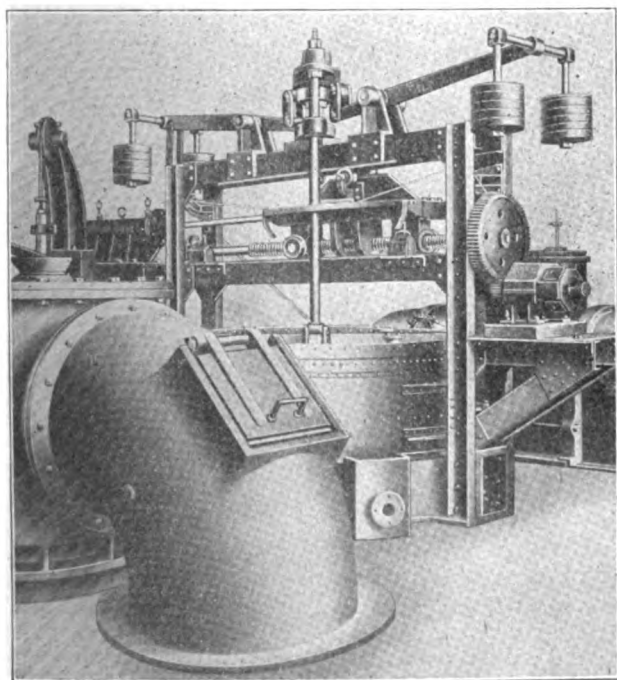


Fig. 4.

raised. While with the ordinary valve construction during reversal the gas flows without resistance to the chimney, in our valve, the loss of gas during reversal is eliminated, therefore resulting in the saving of a considerable amount of gas and coal. In spite of not having any dependable test data, it is safe to assume for a

furnace with a capacity of 100 gross tons per 24 hours that during the whole melting time approximately 40 reversals are necessary and that each reversal requires about 10 seconds; we then have 400 seconds or nearly 7 minutes for every charge. Furthermore for each charge 4 minutes are needed for getting the furnace ready, since this is also done during the middle position of the valve. Thus the valve during each charge lets the gas escape to the chimney for 11 minutes, i. e., for the whole double shift $4 \times 11 = 44$ minutes. If the total coal consumption is taken as 24 gross tons in 14 hours and the price

at \$3.00 per ton, we have a saving of coal of $\frac{1440 \times 24}{44} = 785$ or about 800 kg. or 1,765 lbs., which corresponds to a saving of about \$2.36.

As a matter of fact, the escape of gas during reversing should be assumed to be much higher, since the gas flows in the direction of the chimney with almost twice the velocity, on account of not finding any resistance. For this reason it is a very conservative estimate to place the saving from a 25-ton furnace at \$4.75 for double shift.

In general, the cylinder valve is operated by hand, but for larger valves, automatic operation is advisable, especially then when the bell valve is operated simultaneously with the gas valve and the air valve. For the automatic operation, electricity, compressed air or high pressure water are acceptable. In most cases, however, electricity will be preferred, since electric power is no doubt to be found in every steel plant and the operation of the electric motor is very simple.

In the design shown in Fig. 4 electric power is used together with compressed air in order to permit in case of necessity the use of one power for the other, thus preventing long shutdowns.

The operating motor is reversible and moves back and forth by means of gear strains and a screw shaft, a curved disc which is located in a horizontal receptacle.

SUCCESSFUL USE OF BLAST FURNACE GAS.

Extraordinary results have recently been achieved in the John Cockerill Works at Seraing, Belgium, by the utilization of blast-furnace gas as a source of power. For a period of seven months, the whole of the electrical power required, has been produced by gas engines driven by the gas supplied from a single blast-furnace. The results certainly tend to prove the reliability of the gas engine to be equal to that of the steam turbine; in fact, the power produced in this manner, is equal to more than twice that available from the steam turbine.

When it has been necessary to stop the furnace for a short while, the time chosen has generally been when the power station might conveniently be closed down, say, Sunday. To re-start, the furnace has been blown by a cupola fan, giving sufficient gas to purge the mains up to the gas-cleaning plant. This has then been started, and gas delivered at sufficient pressure to allow of the engine running.

Tests show that 35 per cent gas is absorbed by the hot-blast stoves, 10 per cent by the gas-blowing engines, 5 per cent lost, and 50 per cent available for the gas-driven central electrical power station. For a consumption of 200 tons coke per 24 hours, the load shown at the central station was 4,000 kw., equal to an average load on the gas-engines of 77 per cent of their fuel power.

Iron and Steel Classified for Designers

A Brief Survey of Wrought Iron, Malleable Iron, Cast Iron, and Semi-Steel with Special Reference to the Physical Properties, Characteristics, Common Uses and Heat Treatment of the Same.

By WM. J. MERTEN

Materials and Process Engineering Department, Westinghouse Electric & Manufacturing Company

ONE of the functions of engineering is the utilization of theoretical knowledge and available experimental data coupled with practical experience in the solution of similar problems. In the construction or design of a machine or structure, the analysis of such problems requires two distinct phases of engineering knowledge, one is purely designing, the other involves the selection of proper materials and their application. A systematic and intelligent survey of the known metals and materials and their characteristics is of primary importance in order to produce a safe and economic machine or apparatus.

The selection of the best suited materials requires:

1. A definite understanding of the specific phys-

example, a low carbon steel in its annealed condition answers where malleability is wanted and moderate stresses are encountered. This same low carbon steel carburized and properly treated answers for heavy wear resisting service, such as journals for shafts, running at fairly high speed, camshafts, gears, piston pins, etc. A medium carbon heat treated steel gives strength, toughness and fatigue resistant properties wanted in axles, tires and rails, motor shafts, crankshafts, etc. A high carbon steel, treated, gives external hardness, high elastic limit and comparatively low ductility. Carbon spring steels are of this class and, when carefully manufactured, possess elastic properties highly desirable in this type of machine.

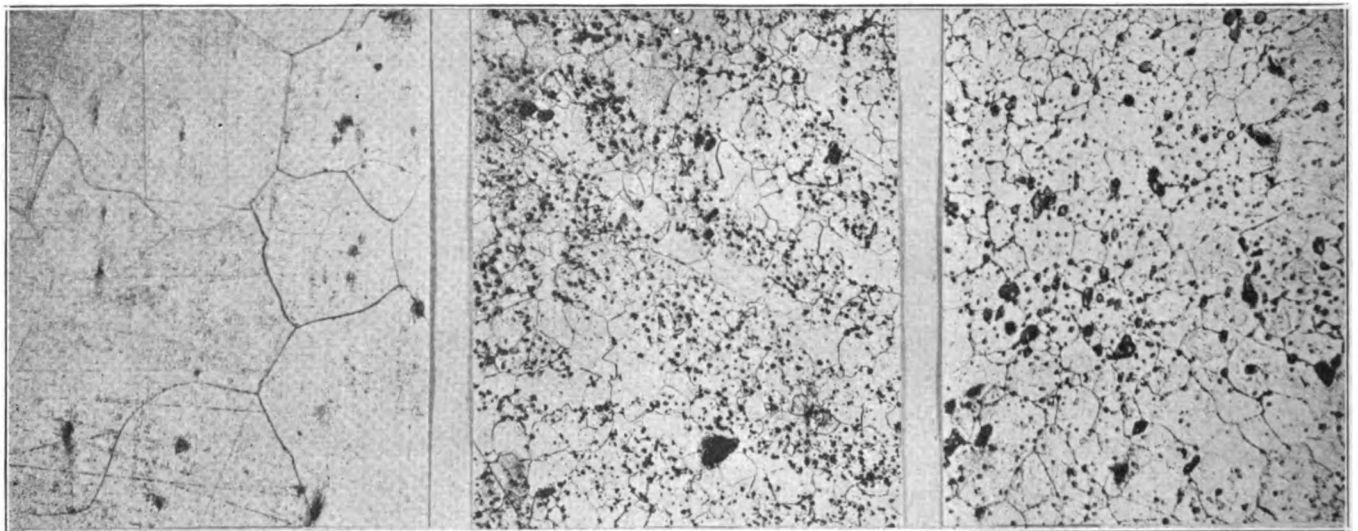


Fig. 1—Coarse grained wrought iron after forging and welding.

Fig. 2—Wrought iron annealed 825 deg. C. for 48 hours.

Fig. 3—Wrought iron refined by heating to 925 deg. C. and air cooled.

Magnification $\times 55$ diameters in each case.

ical properties which can best meet the particular requirements; that is, whether hardness, strength, toughness or some other property is most desirable to render the metal resistant to the stresses to which it is to be subjected. This is a very important point and only meager information and data are usually obtainable, being however, the determining factors in choosing from the ferrous or non-ferrous groups of alloys.

2. It is essential that the modifications of the physical properties and characteristics that may be brought about by thermal or mechanical treatment be known. By one or another of the usual methods of heat treating the same material may be made to answer the requirements of entirely different service stresses. For

3. A fair understanding of proper methods and equipment for such treatment and processes is necessary in order to correctly prescribe them and predict with some degree of assurance the performance of the treated part.

4. The effect of mass and sections upon the rate of cooling, upon the resulting hardness and other physical properties of steel must be understood. Non-uniform sections contribute to warping and cracking of intricate dies, tools and machine parts. Surface imperfections influence the strength of the part being heat treated, drilling, punching, rough turning, polishing, saw cutting and shearing all have a positive or negative effect upon the strength of the material. Even

cooling of all parts is more essential than drastic cooling. Uneven cooling and the consequent distortion by enormously high internal strain is responsible for many failures which might be prevented by proper agitation of and continuous cooling, in an evenly tempered bath. Inactive layers of oil or water become heated forming non-heat conducting gas pockets which result in soft spots in the heat treated part. These soft spots are responsible for an early failure of the part because of the non-uniform structural condition. Obviously these are all factors of greatest importance.

5. The influence of alloying elements, differentiation between steel castings, drop forgings, press forgings, cold drawn parts and a knowledge of the advantages and short comings of forge welding, gas welding, electric welding (fusion, resistance and arc weld) is needed for the designing and production of a machine of merit.

Characteristics, Common Uses, and Heat Treatment of Wrought Iron.

Characteristics.—Wrought iron is made by the puddling process and is the purest variety of commercial iron, usually containing less than .08 carbon and approximately 1.00 per cent slag, the peculiar orientation of which is responsible for its remarkable resistance to corrosion and for its fibrous structure, allowing a large degree of plastic flow or movement within its crystal aggregate which makes it weak in compression. Wrought iron is very ductile and malleable, bending through an angle of 180 degrees or doubling flat on itself without breaking. It melts at a temperature of 1600 deg. C. and is still sluggish and viscous at temperatures so high that it is not practical to cast it into molds.

Uses.—Wrought iron has high magnetic permeability, making it useful for lifting magnets. It is made into wire, sheets, rods, nails, spikes, bolts, chains, anchors, horse-shoes, tires, agricultural implements, boiler-plates, stays, grate-bars, etc.

Heat Treatment.—Wrought iron of fine grain structure is produced by forging or hot working. When reheated it undergoes a slow grain growth at a temperature of 500 deg. C.; this growth becomes more rapid between 700 deg. and 750 deg. C. and a prolonged heating at this temperature will produce an exceedingly weak and coarse grain, which is not altered or refined below or at 870 deg. C. Heating to about 900 deg. C. to 925 deg. C. will cause a breaking up of the coarse granules and results in a fine grain structure of good strength.

Wrought iron chain and crane equipment, when heated for welding of links and rings, has sections heated within this range of dangerous grain growth. To break up and reduce this coarse grained structure a heat treatment consisting of heating to 925 deg. C. followed by an air-cooling is given.

This difference in grain size of refined and coarse iron is shown in Figs. 1, 2 and 3, and the increase in values and magnitude of physical properties is given in Table I.

Ingot iron, a commercially pure iron made in the open hearth furnace, when worked at temperatures below 1000 deg. C. develops abnormally large crystals and will break and fail on forging, exhibiting the phenomenon called "Red shortness." Ingot iron is red-short between 800 deg. C. and 1000 deg. C. The rolling and hot working temperature is kept well above the upper limit to produce sound sheets and bars.

Malleable Iron, Its Characteristics, Uses and Heat Treatment.

Characteristics.—Malleable iron is cast iron of special chemical composition, melted in a reverberatory or air-furnace, and on rare occasions in a cupola, then cast into molds of its final form. The resulting casting is entirely white or all carbon is present in the combined form as iron carbide (Cementite Fe_3C).

Annealing in iron scale (Fe_3O_4) and sand packing at a temperature of from 760 to 925 deg. C. for a time period of 40 to 60 hours changes the carbide to the free amorphous carbon and ferrite, thereby rendering the casting malleable and very ductile at room temperatures.

Malleable iron is lower in carbon, silicon, sulphur, phosphorus and manganese than gray cast iron. It is, therefore, more viscous and must be cast from a higher temperature than the former; consequently it requires greater skill and care, on the part of the molder, to avoid misruns and excessive washing and scoring of the mold from the highly heated metal.

Malleable iron castings combine the advantages of ordinary gray iron castings with respect to the ease of production and cost, with a ductility and strength approaching that of steel.

A typical composition of malleable iron is as follows:

Graphitic Carbon	Combined Carbon	Silicon	Manganese	Phos.	Sulphur
2.50	.01	1.00	.20	.20	.06

The resistance of malleable iron to shock is great and this in conjunction with good ductility, causes it to flow under shock, and renders it highly resistant to fatigue stresses, crystallization, or low temperature effect. It resists corrosion well and its coefficient of friction is less than steel.

Uses.—Cylinder castings, bearings, shells, refrigerating cylinders and pipes, castings for air valves, ammonia castings and motor bearing housings and frames, sprocket chains, conveyor chains, parts of machinery where anti-friction and non-corrosive properties and strength is a desirable combination, auto-

TABLE I—PHYSICAL PROPERTIES OF WROUGHT IRON.

	Ultimate Tensile lb./sq. in.	Yield Point lb./sq. in.	Elonga- tion in 8".	Reduction Area.	Brinell Hardness.	Specific Gravity.	Specific Heat.	Coefficient Expansion 100° F.
As rolled	48,000-50,000	32,000	30%	26%	90	7.78	.11	.00068
Normalized	50,000-52,000	40,000	28%	30%	120	7.78	.11	.00068
	Melting Point. 1600° C.	Modulus of Elasticity. 25,000,000		Resistance per cm. ft. 60		Temperature Coefficient of Resistance per deg. F. .0032		

mobile accessories, such as clamps for wheel rims and buckles for tire straps and holders.

TABLE II—PHYSICAL PROPERTIES OF MALLEABLE IRON.

Specific Heat	.1298
Specific Gravity	7.21
Ultimate Tensile, lbs. per sq. in.	50,000
Yield Point, lbs. per sq. in.	20,000
Elongation in 2 in.	8%
Ult. Compression	50,000
Modulus of Elasticity	15,000,000
Brinell Hardness	80
Melting Point	2200° F.
Coefficient of Expansion	.00000617

Its application for material in draft gear cylinders is highly satisfactory. Its abrasive friction is very low on account of the carbon existing in the amorphous

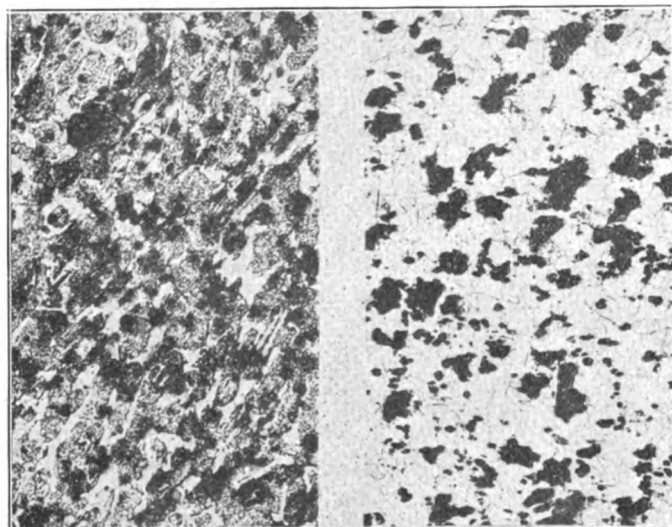


Fig. 4 (at the left)—White iron as cast showing cementite plus cementite eutectic.

Fig. 5 (at the right)—Malleable iron structure in which the carbon is all separated out. The fracture is sooty and black.

form, preventing the surfaces from becoming glazed under constant frictional wear.

Heat Treatment.—Heat treatment of malleable iron consists in heating for malleableizing by annealing the casting at the correct temperature and for a sufficient time period.

Annealing temperatures of malleable iron are materially influenced by its chemical composition, especially by the percentage composition of sulphur and phosphorus, the temperature being higher as the percentage of phosphorus and sulphur rises. However, no detrimental effect because of the increase in these ingredients is noticeable after proper annealing unless this increase is abnormally large.

Figs. 4 and 5 show the structure of malleable iron as cast and after being properly annealed.

The transverse strength of a 1-inch square bar on supports 12 inches apart is 4500—5000 pounds.

Deflection— $\frac{3}{4}$ -inch to $1\frac{1}{4}$ -inch.

Modulus of rupture—55,000 lbs. to 90,000 lbs. per sq. in.

Gray Cast Iron—Its Characteristics, Uses and Heat Treatment.

Characteristics and Uses.—Cast iron differs markedly from wrought iron and steel, chemically as well

as in physical characteristics. It has a coarse, crystalline grain structure, lacks toughness and is brittle at all temperatures below its melting point. The tensile strength is not affected at temperatures below 1000 deg F. but falls off quickly near the critical range and becomes very low at high temperatures.

It melts at a low temperature, 2200 deg. F., and passes suddenly into a very fluid state and fills the molds well when cast.

Cast iron is used for columns, posts, bases, bearing plates, machinery frames, motor bedplates and frames, and other structural parts where complex forms not subjected to severe service are needed and it is without a competitor in this line.

Gray cast iron contains a large amount of graphitic carbon, appearing in an irregular elongated aggregate of crystalline carbon resembling curved flakes or plates imbedded in a matrix of ferrite and cementite. The percentage of free graphite or graphitic carbon in gray cast iron depends upon the percentage composition of the other chemical constituents of the iron, such as silicon, manganese, sulphur, phosphorus. Silicon more especially influences the separation of graphite on

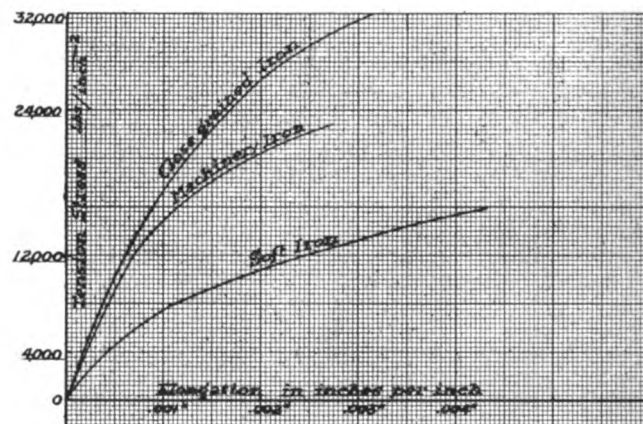


Fig. 6
Stress-Strain Diagram for Cast Iron Tension

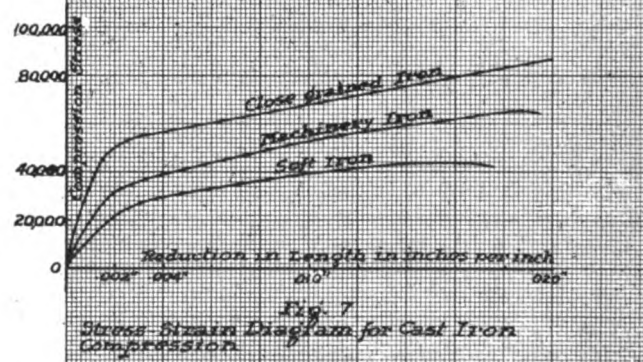


Fig. 7
Stress-Strain Diagram for Cast Iron Compression

cooling of the iron from the liquid to the solid. However, ordinary machinery iron contains approximately 3 per cent carbon and .50 per cent combined carbon. A typical composition of gray machinery iron castings is as follows:

Graphitic Carbon	3.1 %
Combined Carbon	.40%
Manganese	.45%
Sulphur	.09%
Phosphorus	.40%
Silicon	2.25%

The relative proportion of combined and graphitic carbon is of greatest importance and is the determining factor of the physical characteristics of the iron. The variation of the percentage of elements other than carbon is of importance only with respect to their influence on the proportion of combined and graphitic carbon. Silicon decreases the percentage of combined carbon, while manganese, sulphur and phosphorus increases it. Phosphorus, however, reacts in this manner only when present in fairly large quantities; its beneficial action in cast iron consists in reducing the melting point, making the iron very fluid. For perfect

working values of modulus of elasticity are given in Table III.

Cast iron shows enormously wide variations in compression strength values. Very large and long structural columns rarely have an ultimate crushing strength more than 30,000 lbs. per square inch. Short small sections, however, have a crushing strength of from 50,000 to 150,000 lbs. per square inch.

Moduli of elasticity in compression are very much better than in tension and are 30,000,000—20,000,000, and 12,000,000 for the three classes of iron at about

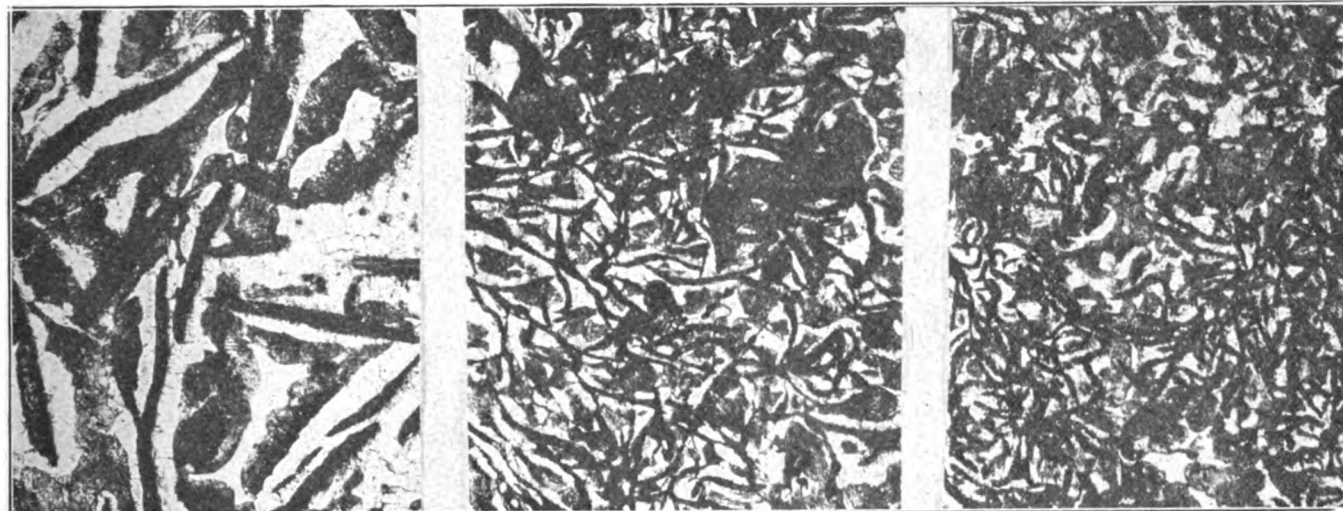


Fig. 8—Very soft and open gray cast iron showing large flakes of graphite. This is a very weak iron.

Fig. 9—Ordinary gray iron for machinery castings. Magnification $\times 75$ diameters in each case.

Fig. 10—Close grained iron of fairly high strength.

impressions of ornamental designs iron of high phosphorus content (about 1 per cent) is used.

Other factors influencing the strength and physical properties of cast iron are:

1. Size of Casting.
2. Method of Molding or Founding.
3. Design.

It is obvious from the above that cast iron has no well defined elastic properties. The yield point varies from 5000 lbs. for soft iron to 22,000 lbs. for close grained iron and the ultimate tensile strength varies from 15,000 lbs. per square inch for soft iron to 35,000 lbs. for hard iron.

The modulus of elasticity also varies with the quality of the iron and changes with the intensity of the stress, or expressed in other words, (1) The slope of the gradient of the stress-strain curve is different for the different grades of iron. (2) The stress strain ratio is constant for very small loads or stresses only and changes or diminishes for larger loads or stresses, from 29,000,000 for close-grained iron at 3000 lbs. per square inch load to about 18,000,000 at 18,000 lbs. per square inch load.

For machinery iron the modulus of elasticity for small loads up to 3000 lbs. per square inch is about 24,000,000 lbs. per square inch and falls to 15,000,000 at 15,000 lbs. per square inch load. For soft iron the modulus of elasticity is about 14,000,000 at loads up to 3000 lbs. per square inch and 7,000,000 at 8000 lbs. per square inch load. This behavior of cast iron is illustrated in stress strain diagram, Fig. 6, and average

15,000 lb. per square inch stress, reducing to 24,000,000, 15,000,000 and 8,000,000 respectively at 24,000 lbs. per square inch stress.

Transverse strength, or cross breaking strength, of cast iron, is now universally accepted as the criterion of the quality of the iron—and the extreme fibre stress produced, causing rupture, is the modulus of rupture and is 52,000 pounds per square inch, 45,000 pounds per square inch, and 40,000 pounds per square inch, respectively, for close grained, machinery, and soft gray iron. The distance between supports is 12 inches. (See Fig. 1 and Table III.)

Figs. 8, 9 and 10 strikingly demonstrate the differences in micro-structure between the various grades of iron.

Heat Treatment.—Thermal or heat treatment of gray cast iron usually consists of chilling the metal in the mold during solidification from liquid. For example: Chilled cast iron rolls, car wheels and hammer blocks. Close grained internal combustion cylinder castings are frequently heated to around 480 deg. C. to 540 deg. C. to relieve casting strains.

Semi-Steel (High Test Gray Iron), Its Characteristics, Uses and Heat Treatment.

Characteristics.—Semi-steel is gray iron of such composition with regard to silicon and carbon as to give the highest possible strength in conjunction with other properties and characteristics inherent to gray cast iron. Properties such as high compressive strength, low coefficient of expansion, rust-resisting qualities, low melting point, high abrasive resistance, great hardness, wearing properties, and others are ob-

TABLE III—PHYSICAL PROPERTIES OF CAST IRON

	Ultimate Tensile Strength in Lbs. Per Sq. In.	Yield Point in Lbs. Per Sq. In.	Ultimate Compressive Strength in Lbs. Per Sq. In.	Modulus of Elasticity in Tension.	Modulus of Elasticity in Compression.	Modulus of Rupture in Lbs. Per Sq. In.	Melting Point in Degrees Fahr.	Coeff. of Expansion per ° F.	Electrical Resistance per Circular Heat. Mill Foot.
Close Grained Cast Iron	35,000	20,000	120,000	30,000,000 at 3,000 lbs./in. ² Load to 15,000,000 at 10,000 lbs./in. ² Load	30,000,000 at 15,000 lbs./in. ² Load to 24,000,000 at 24,000 lbs./in. ² Load	52,000	2200	.0000068	.11 684
Machinery Iron	30,000	15,000	100,000	24,000,000 at 3,000 lbs./in. ² Load to 14,000,000 at 10,000 lbs./in. ² Load	20,000,000 at 15,000 lbs./in. ² Load to 15,000,000 at 24,000 lbs./in. ² Load	45,000	2200	.0000068	.11 684
Soft Iron	25,000	10,000	90,000	12,000,000 at 3,000 lbs./in. ² Load to 7,000,000 at 10,000 lbs./in. ² Load	12,000,000 at 15,000 lbs./in. ² Load to 8,000,000 at 24,000 lbs./in. ² Load	40,000	2200	.0000068	.11 684

tained by melting a mixture of foundry pig iron, gray iron scrap, and from 10 per cent to 40 per cent low carbon steel scrap in a cupola and casting the liquid iron into green sand molds.

Uses.—For castings requiring strength, wearing qualities, heat resisting properties, and close grain structures impervious to air, steam and water, semi-steel castings have no equal.

For hammer die blocks and die liners for piercing or extruding dies and tips for piercing arbors. Semi-steel made by melting with pig iron, and gray iron scrap a 40 per cent addition of steel scrap has given very much superior service at one-fourth the price per pound of high grade special steels.

An average chemical analysis of such die liners is as follows:

Graphitic Carbon	2.20
Combined Carbon	.80
Manganese	1.00
Silicon	1.30
Sulphur	.08
Phosphorus	.13

The physical properties of the semi-steel whose composition is given above would be:

Ultimate Tensile	49,000
Yield Point	40,000
Brinell	241
Transverse Test, 5,800 lb. load to rupture	
Modulus of Elasticity	8,000,000
Modulus of Rupture of	120,000
Melting Point in deg. F.	2,300
or slightly higher than cast iron	
Coef. of Expansion per deg. F.	.0000068

Heat Treatment.—The thermal or heat treatment of semi-steel consists in chilling of wearing surfaces in the mold when casting the metal. White castings so produced lend themselves to annealing and graphitizing of the combined carbon but this is not practiced commercially. Photo-micrograph 11 is a 10 per cent

semi-steel casting structure from a fairly heavy section (3 in. diam).

Photo-micrograph, Fig. 12, illustrates a chilled section of a liner casting for an extruding die. This mottled hard and brittle jacket cushioned against a soft yielding gray iron section made an ideal die liner

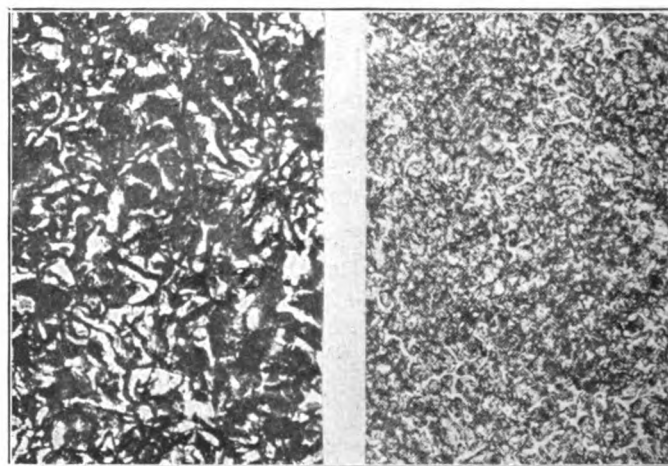


Fig. 11—Ten per cent semi-steel structure from a section 3 inches in diameter.

Fig. 12—Killed part of semi-steel casting. The white areas are cementite in a matrix of an aggregate of ferrite, pearlite and graphite.

and increased production of extruding or piercing steel sleeves from 650 to 750 per steel liner to 4000 to 6000 per semi-steel liner, at a considerably reduced cost per liner.

A comparison with the structure of white iron made in the air furnace for malleabilizing reveals a striking difference, the semi-steel chill being nearer comparable with a steel section at higher magnification. The writer has always attributed this similarity to the high percentage of manganese present in the semi-steel casting.

Acid Open Hearth Process for Manufacture of Gun Steel and Fine Steel

Detailed Description of This Manner of Work, Giving the Various Steps of Manufacture—Result of Investigations Made by Special Committee as to Difficulties Encountered.

By W. P. BARBA and HENRY M. HOWE

PART II

A GOOD deal of metal rich in inclusions is likely to accumulate on the very bottom of the ladle and particularly about the stopper, because the relatively cool ladle bottom cools the steel first tapped upon it, and thus thickens it, and impedes the rising of the inclusions which it contains. Therefore, the first 300 or 400 lb. of steel which run through on raising the stopper should be poured into an old mold set up beside the regular ones, and should be treated as scrap. The ladle should then be brought over the regular molds, but in doing this at so early a stage before the stopper and nozzle have become highly heated, care should be taken not to close the stopper tightly lest it should stick in the pasty metal when we try to re-open it.

37. Temperature and Rate of Pouring.—(a) These need to be governed accurately so as to steer between two grave dangers, that of causing external cracks in the ingot from too hot or too fast pouring; and that of causing external roughness and of increasing the quantity of inclusions by too cold pouring.

(b) As the first part of the liquid steel is poured into its mold, its outer layer which is in immediate contact with the cold iron walls of the mold cools down quickly through the transfer of its heat to those walls, with the consequence that a thin crust of solid steel soon forms on the outside of the mass, and thickens progressively. As it thickens the pouring of the steel continues, so that the top of the column of steel in the mold rises continuously. Thus as the crust of solid steel encasing the still liquid interior of the ingot progressively thickens, it is exposed to a continuously increasing hydrostatic, or ferrostatic, pressure.

This increase may be so rapid that the hydrostatic pressure outstrips the increasing strength of the solid crust of the ingot, and thus bursts it, forming one or more external cracks. These form all the more readily because at this stage the mold itself is rapidly growing hotter, and therefore expanding and drawing away from the ingot crust, the outer layers of which are cooling and hence contracting.

Both hot pouring and fast pouring increase the tendency of the hydrostatic pressure to outstrip the strength of the crust, and thus to crack it—hot pouring because it retards the thickening of the crust, and fast pouring because it accelerates the increase of the hydrostatic pressure. This is one of the most im-

portant reasons for the American practice of cold pouring, the other reason being that it gives quick solidification and shortens the pipe.

Here cool pouring is the equivalent of slow pouring. Each favors the thickening of the solid crust relatively to the lengthening of the column of molten steel, and each thus guards against external cracking. This leads to the simple rule that the steel should be poured at so low a temperature and so slowly that the solid walls at the lower part of the ingot will thicken fast enough to resist the progressively increasing hydrostatic pressure caused by the gradual rise of the upper surface of the metal.

An additional and closely related effect of the slow pouring is to shorten the pipe. This is because the steel cools more slowly in the ladle than in the molds, so that slow pouring prolongs the period during which we add fresh hot steel to the ingot top, while the lower part of the ingot is cooling by transferring heat into the mold walls. In general, slow pouring makes for keeping the ingot top hot.

(c) A further objection to hot pouring is that to raise the temperature of the molten steel is to raise the temperature to which it heats the mold walls at any given instant, hence to retard the cooling of the steel, and in particular to retard its passage through the solidification range. In this way hot pouring leads to a greater degree of differentiation in solidifying, to the formation of larger dendrites, and to a higher degree of enrichment by segregation in the interdendritic spaces and probably in the axial region. The crucible steel maker long ago noticed the marked columnar structure of ingots poured too hot, and called those with this structure "scorched."

38. Cool Pouring.—(a) If, on the other hand, the steel is too cold when it is poured, or is poured so slowly that it becomes too cold before the whole of it has entered the mold, two serious troubles arise. First, the extremely slow rising of the upper surface of the molten metal in contact with the cold mold easily causes the surface to crust over momentarily for a short distance. These slight crustings may not be entirely effaced by the metal poured in later if the steel is extremely cold.

(b) Another and still more serious damage by too cold pouring is the retention of inclusions. Steel poured so cool that the thickness of the solid walls of steel gradually forming in the mold increases fast enough to resist the progressively increasing hydrostatic pressure, must evidently be very near its solidus

*Abstract of paper presented at the New York Meeting, February, 1922, of the American Institute of Mining and Metallurgical Engineers.

as it enters the mold. At any rate, it must be well below its liquidus, and therefore it must be an emulsion of particles of solid steel supported in molten steel. This point must be grasped clearly. The lower the temperature is the greater will be the proportion of solid particles to molten steel; and the more viscous therefore will be the emulsion of which the steel itself consists. Evidently this viscosity impedes the attempt of the particles of slag to rise to the surface.

(c) Another danger in the top pouring of ingots at too low a temperature is that, should the nozzle leak, so that its spittings form a thin sheet which solidifies on the side of the mold above the level of the steel, the metal poured later may not be hot enough to remelt this sheet, which thus remains to form a discontinuity. As it melts at its bottom, it may fall down into the molten metal below, or tilt over and catch on the opposite side of the mold. Evidences of this have frequently been observed and thoroughly traced to this cause.

39. **Summary.**—To sum up the three advantages of cool pouring which we have now seen, that it restrains segregation probably both axial and interdendritic, the size of the dendrites, and the tendency to external cracking, outweigh its disadvantage of favoring the retention of inclusions in the opinion of American open-hearth experts, but not in that of Continental European ones and at least some of the British, who purposely pour their gun steel extremely hot. Indeed, even their workmen regard the external cracking to which hot pouring leads as a favorable symptom, for the cracks can be chipped out while the greater freedom from inclusions persists. In our opinion the question is an open one, to be decided by careful observation. Yet because our paper is to describe American practice, we shall continue to speak of cool pouring as among the aims of the process.

Cool pouring is considered further in Section 47.

40. **Notes on Pouring.**—(a) The interval between tapping and teeming and the rapidity of teeming are governed by the melter's judgment as to the temperature at which the steel left in the furnace, and by the size and number of ingots into which the charge in the ladle is to be poured. The length of time occupied in teeming each ingot should be recorded carefully for the melter's guidance in future cases. If the ingots show external cracks, referable to too hot pouring, he would infer that he had poured too fast for the actual temperature of the steel. If, on the other hand, the ingots show the characteristics which we associate with too cool and hence too slow pouring, such as an excessive quantity of inclusions, he infers that for the existing conditions he has teemed too slowly. Laps and cold shuts on the corners of the ingot are clear evidence of too slow pouring.

(b) Each heat of steel, and each ingot of each heat, forms in itself a problem for the melter, whose judgment and experience are now called into operation, since it is well nigh impossible fully to lay down rules governing the pouring. In all cases the melter, who should be the most experienced man available in the establishment, should himself watch the steel in each ingot as it is rising in the mold, and judge the temperature of the metal and the speed of pouring required for each, carefully recording the actual time and the conditions of the resultant ingot. The proper rate of pouring cannot be predetermined; rather it is estimated by the melter, with his experience in mind, from

the observed temperature of the steel as it rises in the mold.

(c) It is obvious that top-poured ingots are difficult to watch in the way just mentioned. This matter will be discussed more fully when top and bottom pouring are considered (Section 55).

(d) The temperature of the steel in the ladle falls continuously from the beginning to the end of teeming, with the effect that though the metal was slightly above its liquidus on entering the ladle, it falls to materially below it before the teeming is completed, so that some skull often remains. This skull represents metal too pasty, and hence too near the solidus, to flow over the bottom of the ladle. Its presence is a sign that the temperature and rate of teeming have been correct.

41. **Breaking Cream.**—It is a common saying that the appearance of bottom-poured steel as it rises in the mold should be that of "breaking cream." This is readily understood when we remember that the metal poured at the proper temperature is an emulsion much like that of the suspended butter fat of thick cream. Both are subject to crusting over with a very thin crust. In the case of steel, this crust caused by the cooling effect of the air in the neighborhood of the mold is quickly remelted by the hot steel rising from below, if the pouring temperature is proper.

42. **Stop-pours.**—(a) We should pour the steel into each mold without the slightest interruption, lest we form a "stop-pour," a slight freezing of the upper surface of the metal where it touches the mold, and fail to remelt it completely when we resume the pouring. This is especially important in the cool pouring recommended in this paper.

(b) Stop-pours may be made both in bottom-pouring and in top-pouring practice, and sometimes are difficult to detect, especially if the stoppage is very short. In any event, when a stoppage has occurred and the resultant stop-pour has escaped detection, it is likely to be discovered if the ingot is forged, but if the ingot is rolled discovery is much more difficult. Always after a stoppage there is certain to be a defect in the surface, extending to unknown depths into the section. For gun purposes, and others in which the ends only can be inspected and tested, a stop-poured ingot never should be considered for use. There are, of course, occasions when for bar steel or billet production, a stop-poured ingot can be carried forward and the stop-poured part cut out and discarded.

43. **Piping.**—(a) The reasons for the existence of the pipe is already familiar, namely, that at an early stage in the solidification the crust of the ingot has done a greater proportion of its total cooling, and hence of its total contraction, than has occurred in the deeper seated layers, and thus has been stretched by their resistance. Because these deeper seated layers therefore have from this time on a greater range of temperature to cool through than the crust has, they will undergo more contraction than it. This excess of contraction of the interior plus the stretching of the crust are represented by the presence of an axial cavity, or pipe, unless indeed it is compensated for by the formation of blow-holes or gas cavities.

(b) One of us * has already shown that the pipe forms in the last solidifying part of the ingot, whether

*H. M. Howe and Bradley Stoughton: Trans. (1907) 38, 117.

that is at the top or bottom or at the side. Clearly it is well to have the pipe occur at one end of the ingot so as to affect only a short part of its length, and that end is preferably the top for obvious reasons.

Hence the various devices for concentrating the heat at the ingot top, or otherwise causing the solidifying of the top to lag behind that of the parts below, so that, as fast as the pipe tends to form, it may be filled by still molten metal from above. Among these devices, are "hot-tops" to the molds, sink heads, having the large end of the ingots uppermost, pouring slowly, at a low temperature, and at the top of the ingot especially at the last, and of making the mold walls thicker below than above, so that they may cool the bottom of the ingot faster than the top. This will be considered further in Section 55, on top and bottom pouring.

44. Top lag, or the lagging of the upper part of the ingot in the process of cooling, may here be studied a little more closely because it helps explain why small ingots are nearly always top poured throughout, though larger ones are not (Section 55).

In any given transverse slice EE' of a solidifying ingot, the temperature rises continuously as we pass from the outside toward the axis, while it simultaneously rises continuously as we pass from this slice upwards. The tendency to form an axial cavity or pipe proves that, while this tendency exists, the slice EE' as a whole is contracting faster than the crust of the ingot. The parts E and E' are held apart by the rigidity of the crust, and the excess of contraction of the crust gives the different parts of the slice a tendency to draw apart.

Lest it be thought that this tendency to crack open at the axis is confined to the temperature range between the liquidus and the solidus, a range indeed of great weakness, let us remember that pure substances, pure metals, pure eutectic liquids, etc., in which the solidus and the liquidus coincide and there is no freezing range but only a true freezing point, also pipe. Indeed this case is not needed to convince us that the slice EE' may crack at its axis and may thus tend to start a pipe at any temperature at which the stretch AB caused by the resistance of the rigid ingot crust to the contraction of the slice because of its faster cooling, exceeds the stretching power of the metal; or in other words, when the stress so induced exceeds the existing strength of the metal. This range of temperature may extend far below the solidus.

45. Pipe-closing Period.—Imagine that the slice EE' is completely isolated from the mass of metal above and below by the planes which form its top and bottom. In this case the pipe D, representing the excess of induced stretch over capacity for stretch, persists. But if, having thus imagined the creation of D, we next consider the actual conditions in which no such planes exist, we see that all of the metal above this plane which is still hot enough to have any appreciable capacity for flow, begins sagging down to close D, as suggested by arrows C and C', quite as the faces of a prism of soft jelly sag when the mold in which it has set is withdrawn. The curved lines of flow of such concrete masses are not to be confused with the angle of repose of discrete ones like sand. Note that the sides of the funnel-shaped part of any pipe are curved and not straight.

Thus in every imaginary horizontal layer there is

the pipe-forming tendency, representing the excess of induced stretch over capacity for stretch, and the pipe-closing tendency, representing the sagging of the overlying mass, and chiefly of its axial and periaxial parts, which are the hottest and hence the most mobile.

The pipe will stretch down to the layer in which the sagging of the overlying mass just fails to compensate fully for the pipe-forming tendency. Clearly the quantity of sagging down into any given layer must increase with the volume of mobile metal above the layer, and with its mobility, and this latter in turn increases with the steepness of the vertical thermal gradient from this layer up. In other words, in any given horizontal layer, the pipe-closing tendency increases with the mobility and hence with the temperature of the metal above, and these increase with the rapidity of rise of temperature from this layer up. Hence the importance of concentrating the heat at the top of the ingot, thus increasing the volume and mobility of the metal available for sagging down into any given layer, thus raising the position of the layer the sagging into which barely equals in volume the volume which the pipe-forming tendency represents, and thus in fine shortening the pipe.

Because the tendency to pipe is inversely as the steepness of the vertical thermal gradient in the upper part of the ingot, and because this steepness is inversely as the size of the ingot, other things being equal, the tendency to pipe and the depth of the pipe are greater in small than in large ingots. This result represents also the longer time available in large ingots for the sluggish process of sagging.

46. Stub Ingot Pouring.—In making "stub" * tire ingots, that is those the length of which is only 60 to 100 per cent. of their diameter, each making a single tire, the Standard Steel Works Co. combines various steps for causing the cooling of the ingot top to lag and thereby shortening and raising the pipe, and raising and concentrating the segregate so effectively that a discard of only 3 per cent. suffices to remove all unsound, piped, and harmfully segregated metal. This discard is the small disk punched out of the axis of the bloom into which the ingot is forged in working it into the shape of a tire.

Here the cooling of the bottom is hastened by the broad thin cheese shape of the ingot which exposes extended bottom surface to the cold thick bottom of the mold; and the cooling of the top is retarded by a layer of carbonaceous matter, which in burning yields much heat yet without causing material carburization.

47. Cool Pouring Raises the Pipe.—Section 37 shows that in top pouring we may raise the pipe by pouring slowly. Cool pouring has a like effect, as we will now explain. First, let us recognize that the molten steel cools down much more slowly in the ladle than in the molds. With this in mind the effect of cool pouring in raising or even eliminating the pipe can be made clear by considering two imaginary extreme cases.

First let us suppose that the steel when top poured into the mold is so extremely cool that it solidifies very rapidly, indeed almost immediately. In this case, the early poured steel solidifies very early in the pouring, and is thus anchored in place at the bottom of the mold. Each subsequent addition in like manner be-

*Lawford H. Fry: Year Book Amer. Iron and Steel Inst. (1919) 435.

comes anchored approximately at the height in the mold which it occupied when poured. These successive lots thus cool down by the transfer of their heat into and through the mold walls. Because the first poured lot starts this cooling earlier than the later ones, it will at any given instant be the coolest, and each of the successive lots, from the bottom upwards, will be hotter at any given instant than the one next below it. Thus solidification and the formation of the pipe proceed from below upwards, so that each layer, as it enters the mold, finds the pipe already formed or forming in that beneath it, and thus has the best possible opportunity to fill it. Indeed this, like any other means of causing the solidification of the top to lag behind that of the lower parts, clearly tends to raise the pipe.

In bottom pouring the same is true, save that here we must conceive that the steel is at all times hot enough to keep a channel open through the earliest poured and earliest frozen layers at the bottom.

Turning now to the opposite extreme, let us suppose that the steel is so hot that none of it freezes before the whole ingot is poured. In this case the falling or rising stream keeps the whole mass in motion, so that the parts poured first become mixed with the rest, and that the progressive rise of temperature from the bottom upwards, so favorable to the raising and shortening of the pipe, is reduced to a minimum.

The principle which governs these two extreme cases applies to any intermediate one. The cooler the steel the more of the early poured parts will solidify and become anchored in the lower part of the mold, and the more rapid will be the rise of temperature at any given instant from the bottom toward the top, and hence the shorter and higher up will be the pipe.

48. Shape of Molds.—In designing the molds there are four important ends to be sought:

- (a) That they shall have enough taper to prevent the ingots from sticking to them, but no more.
- (b) That the crust of the ingot shall not be cracked transversely by its inevitably cooling and contracting faster than the deeper seated layers.
- (c) That it shall not be cracked longitudinally by the same cause.
- (d) That the pipe shall be shortened and raised as far as possible, or better still eliminated.

Let us consider the means to certain of these ends.

49. Taper.—(a) The taper is almost the same in ingots of five sizes, taken from current good practice, varying from 0.40 to 0.43 in. in diameter to the running foot.

(b) On pouring the ingot into its mold, its skin solidifies when its temperature is much above that of the mold so that the ingot in cooling has a greater range of temperature through which to cool than the mold, and hence contracts more. This excess of contraction of the ingot would naturally cause a gap between them, so that it might be expected that, were both perfectly smooth, no taper would be needed. In fact, neither is quite smooth. The ingot especially is likely to have roughness which may cause it to stick in the mold. Moreover, part at least of the gap to be expected between ingot and mold is effaced by the stretching of the ingot's crust caused by the resistance

to its contraction by the slower cooling and contracting deeper seated layers, as well as by the stretching due to ferrostatic pressure.

(c) It is to afford the clearance needed for easy stripping that the taper is given.

(d) The amount of taper should be the minimum which experience shows is needed to enable carefully poured ingots to be removed from carefully prepared molds, because any great excess of taper makes the work of forging more difficult, and also leads to the faster heating of the smaller than of the larger end of the ingot.

(e) Further to prevent this sticking, the inner surface of the mold should be examined carefully to detect any roughness, and it should be coated, for instance with a wash of bone graphite and water, and polished to a "kitchen range" surface.

(f) It might at first be thought that more taper would be needed in small than in large ingots, because the average temperature of a large ingot at the time when its crust is solidified by being cooled by the mold and its external dimensions are thus determined, is higher than that of a small ingot. This suggests that the average contraction of a large ingot is greater than that of a smaller one. Because this excess of contraction helps to free the ingot from the mold, less taper would naturally be needed to give enough free space to enable the ingot to slip past the mold.

(g) But this advantage of the larger ingot is counteracted by its disadvantage as regards the stretching of its crust by the resistance of the slower cooling deeper seated layers. Both large and small ingots are stripped as soon as they have cooled far enough to be handled without danger of breaking, when the faces of the octagon or square are at about 850 deg. C. (1562 deg. F.), and the edges or corners are black, and these temperatures are about the same for large as for small ingots. But the average temperature of the large ingot at this time is much higher than that of the small one. Hence, the resistance of the slower cooling interior of the large ingot stretches its crust by an amount greater than the corresponding stretching of the crust of the small ingot. This greater stretching of the crust of the larger ingot lessens the clearance between ingot and mold, and this offsets to a certain degree, and perhaps completely, the excess of contraction of the large ingot to be expected from the considerations set forth in the preceding paragraph.

50. Prevention of Longitudinal Cracks by Giving the Crust of the Ingot an Accommodating Shape.—(a) A circular gutter pipe filled with water bursts on freezing, because the circular form of the metal has too little power of elongation to accommodate itself to the expansion of the freezing water. But a corrugated gutter pipe does not burst, because while its metal has no more capacity for elongation than that of the circular one, it has an accommodating shape.

(b) Following this line of reasoning, the crust of the ingot is given a similar accommodating shape, often that of a fluted octagon, in order that it may not be torn apart by longitudinal cracks in the early stage of solidification, when it is thin and tender, by the resistance to its contraction offered by the slower cooling of the deeper seated layers; but that instead it may bend and thus accommodate itself to the resistance.

(To be continued)



Improved Method of Burning Coal

Methods and Results Obtained from Wetting Coal with Exhaust Steam for Chain Grate Stokers—Ash Is Generally Much Better When Wet Coal Is Used.

By C. E. HAYES

IT has long been an established fact that certain kinds of coal burn better on chain grate stokers when properly wet than when burned dry. This fact is particularly true of the coals of Western Pennsylvania, Ohio and West Virginia.

In order to determine if a certain coal will give more efficient results when burned wet than dry, it is necessary to test it. This is very easy to do.

First, enough coal is placed in a pile on the floor to run the stoker for about an hour or two. This coal is dampened thoroughly with a hose and turned over several times with a shovel until it is uniformly wet through.

It is of great importance to have the coal uniformly wet and to see that there is just the right amount of moisture in it. Every one knows that the water in the coal has to be boiled and superheated to the temperature of the flue gases. This, of course, is a loss, and the more water in the coal, the greater the loss. While this loss—caused by wetting the coal—is more than made up by the added efficiency obtained, it is well to bear in mind that the coal should not be wet more than will produce the best results.

After a good deal of experimenting, it was found that the most practical method of telling when the coal has enough moisture in it, and still not too much, is to take a handful and press it tightly together. If it has sufficient moisture to mould and is not so wet that the water will run out of it, the best results will be obtained.

After the pile of coal to be tested has been dampened, level off the coal in the stoker hopper and put the wet coal in. Careful observations of the fire and ash should be made after the wet coal is put in the hopper. A decided improvement will be noticeable with most coals, as soon as the wet portion works back. The writer has observed that in most plants where this was tried, a straight line could be seen coming back across the boiler, separating the good fire obtained by burning wet coal from the poor fire of the dry coal. The ash is generally much better when burning wet coal.

In one installation, where force draft chain grate stokers are used, it was almost impossible to burn the

coal dry, but after it was dampened much better results were obtained.

After it is established that a certain coal will burn better when wet, the question arises as to how to wet it successfully in actual practice.

The most general, but not the best, method is to install water pipes above the stoker hoppers and spray water on top of the coal. This method will work fairly well, but has decided disadvantages. In the first place, it does not wet the coal uniformly without putting a large excess of water on the coal. This excess of water not only means loss of efficiency, but it runs through the coal onto the stoker. Very often this water, after passing through the coal, is very corrosive and will damage the stoker. This is particularly true of force draft chain grate stokers.

If only a small amount of water is sprayed over the coal, it will make paths through the coal for itself and only wets a very small portion of the coal. This uneven wetting is worse than no wetting at all, because it makes the fire burn uneven.

To overcome this disadvantage of using water, the following method was installed and proved not only entirely satisfactory, but an improvement over the old method of using water.

There is generally an excess of exhaust steam around the boiler room of a steel mill. This exhaust steam was used to wet the coal. A two-inch pipe was placed in the stoker hopper 12 inches above the grate, and as near the front as possible. Into this pipe were set a row of brass plugs one inch apart, each with a 3/16-in. hole in the center. These brass plugs can be eliminated and the 3/16-in. holes placed in the pipe itself. If this is done, however, trouble may develop due to the holes stopping up with corrosion caused by the action of water on certain kinds of coal.

The 2-inch pipe with the holes in it was placed so that the holes faced in towards the boilers and down 15 deg. below the horizontal. This 2-inch pipe was connected to the exhaust steam header with a valve near the stoker so the amount of steam can be regulated, or shut off if the stoker is not in use.

The above arrangement has been given a thorough trial and found to be far superior to any method of using water. It wets the coal much more thoroughly and more uniformly without any excess of water. The coal will be wet enough to give the best results and still

no water will run through the grates.

No trouble was experienced with escaping steam above the hopper as long as it was kept reasonably full of coal.

Economizers and Economizer Operation

Theoretical Need of Economizers—Progress Made in Steel Tube Economizers—General Review of the Advantages and Disadvantages of Economizers.

By FRANK H. PROUTY

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THE first economizer installation dates back more than 100 years; every year has seen an increase in the number of installations, yet it may be said that the economizer is still in a period of trial and transition and has never been fully accepted by the American engineering profession.

Old Installations Often Inefficient.

Certainly there are a number of economizers throughout the country which positively detract from the overall efficiency and which it would be cheaper to remove or permanently by-pass than maintain in operation. Such results may come from insufficient stack draft, improper proportioning of economizer heating surface to boiler heating surface, feed water temperature under 100 deg. F. causing extreme external corrosion and excessive soot caking, feed water temperature over 200 deg. F. which may be too close to the breeching temperature for sufficient heat transfer or the not uncommon failure due to neglect in operation. On the other hand there are economizer installations which will meet the manufacturers' entire claims and which are indispensable to high efficiency. Such results are obtained when there is 350 deg. F. to 450 deg. F. difference between entering feed water temperature and breeching temperature, an induced draft fan to provide ample draft, a proper relation between boiler heating surface and economizer heating surface, a counter flow relation between water and gases and a clean economizer.

Theoretical Need of Economizers.

The theoretical need of economizers becomes apparent for if heat is to be imparted to the boiler throughout the travel of gases over the tubes, the gases must manifestly leave the tubes at an appreciably higher temperature than the steam and water within. If the steam temperature is 375 deg. F. and the gases have an excess temperature of 125 deg., then the resulting stack temperature of 500 deg. may represent a loss of 15 per cent of the total heat available. A counter flow type of economizer placed between the feed pump and the boiler and in this flow of gases will most effectively reduce the gas temperature, the water having a high boiling point due to its pressure and high heat absorption because by flowing in a direction opposite to the flow of gases, there is always a maximum temperature difference between the two. The counter flow principal also minimizes temperature strains and with cast iron tubes and headers, this item rises to prominence.

The lower the temperature of the feed water entering the economizer, the lower will be the final gas temperature, yet the former should never be below 100 deg. F. and preferably well above this figure because low feed water temperatures cause moisture in the flue gases to

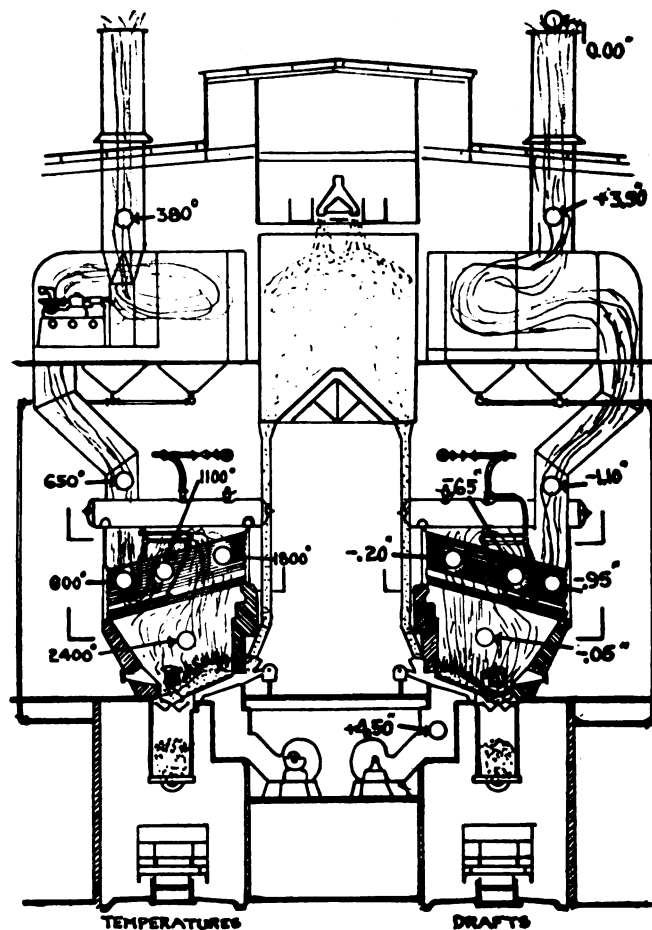


Fig. 1—Typical temperatures and drafts with Green economizers in a modern boiler house.

condense on the tubes and headers and this moisture combining with the sulphur usually present in the gases, forms sulphuric acid and rapid corrosion invariably results.

Economizers as Purifiers.

Economizers in a limited manner act as purifiers, causing the deposit of part of the solid matter held in suspension and precipitating out a large portion of the carbonates held in solution. Most scale is formed by the carbonates and sulphates of magnesium and calcium, the carbonates resulting in temporary hardness and the sulphates in permanent hardness. As only the carbonates are precipitated out in an economizer, it may be said that its purifying action deserves small consideration, it doing little more than relieving the boiler blow-off of carrying away a portion of sludge.

Progress Made in Steel Tube Economizers.

Economizers in this country have generally been made of cast iron and because of the tensile weakness of cast iron for high feed water pressures, numerous attempts have been and are still being made to perfect a steel tube economizer. Steel tube economizers have proven unsuccessful in the past because of excessive internal corrosion due to air held in solution with the feed water. Attempts to galvanize and otherwise coat the inside of steel tubes failed to prevent corrosion. However, recent experiments have shown that the air in feed water may be greatly reduced by maintaining a heater temperature near the boiling point, by filtering, or by forcing preliminary oxidation by passing the feed water over iron filings placed in the heater outlet. An improved method now being commercialized is to boil the water under a partial vacuum. This method not only gives an increased extraction of air, but has the additional advantage of treating water with a temperature well under the atmospheric boiling point. This latter point particularly benefits where the temperature of gases flowing through the economizer require that for maximum heat extraction the feed water temperature be down around 150 deg. F. A number of steel tube economizers are now under trial and with the present development of deaeration, some installations will undoubtedly prove successful. Cast

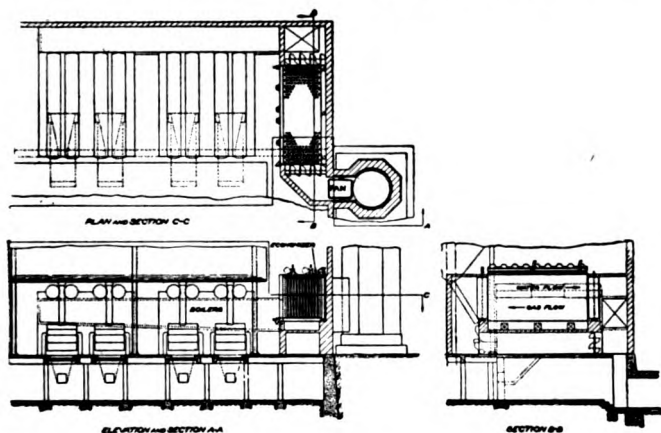


Fig. 2—Showing one Sturtevant economizer serving more than one boiler. The tendency is toward individual economizers for each boiler.

iron economizers are also subject to internal corrosion, but so moderately that in very few cases has internal corrosion caused failure.

Replacing Mechanical Scrapers by Soot Blowers.

Economizer tubes collect an external deposit which requires constant removal and some economizers are equipped with mechanical scrapers for removing this deposit. There is a considerable amount of mechanism to these scrapers and, in recent years, a strong movement

has been made to replace them by soot blowers. Soot blowers require less exposure of the attendant to the excessive radiant heat of the economizer, they can keep the economizer tubes cleaner, have a lower initial cost and can be operated and maintained at a considerably less cost than can mechanical scrapers. However, mechanical scrapers will successfully do their work and they have advantages in that they deposit the scrapings into the hopper underneath the economizer while the

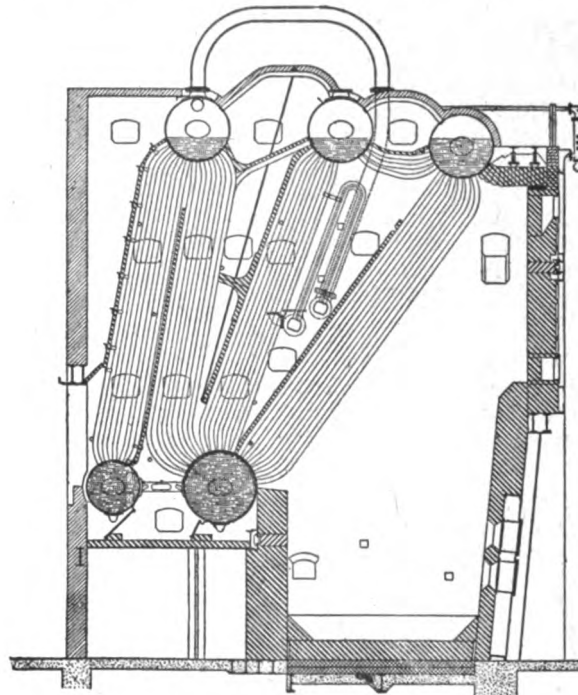


Fig. 3—Babcock and Wilcox Integral Stirling-Tube Economizer.

soot blower blows most of the cleanings out of the stack and the scrapers operate dry while the soot blowers deposit a certain amount of moisture on the tubes. The latter advantage is of small importance where the water entering the economizer is close to 200 deg. F. and where superheated steam is used to blow, the use of soot blowers may cause rapid and disastrous corrosion of the economizer. Some manufacturers factory equip their economizers with soot blowers, while in other instances scrapers have been replaced by soot blowers after the original installation.

Induced Draft Fan Necessary.

It may be said almost without exception that good results will not be obtained from an economizer unless it is used in conjunction with an induced draft fan. The loss of draft gas due to gases cooled to around 350 deg. F., together with the additional resistance necessary to pull the gases through the economizer would require a stack prohibitive in size to carry peak loads or run high ratings.

The commonly used induced draft fan and short stack result in the emission of large quantities of dust, the controlling of which gives rise to a problem of considerable magnitude. This dust has been successfully controlled by an induced draft fan which also embodies a centrifugal dust catcher, the dust being driven by centrifugal force to the outside periphery of the fan where it is deposited and collected. This method removes but a portion of the total dust and the upkeep cost is large due to the abrasive action of the particles. Another method is to wash the dust out of the gases by passing them

through washers. This method is expensive to install and a loss occurs in stack draft due to a cooling of the gases. The cheapest and simplest remedy seems to be that of attaching a collecting hopper to the boiler breeching and baffling the gases down against a series of louver blades placed in the top of the hopper. These blades snub the dust particles and cause them to drop into the hopper below. As this dust often contains from 60 to 65 per cent fixed carbon, it is possible to burn it on a Coxe stoker.

Economizer Operation.

Cast iron economizer tubes are usually cleaned with water driven turbines, the water acting as a cushion and preventing the turbine from smashing the tubes. However, an air driven turbine can be used with equal success if equipped with a limit ring. After cleaning economizers several times it is often difficult to prevent the caps from leaking. In such cases hot joint paste is superior to pastes of lead or shellac.

When economizers are newly installed it is not unusual to experience a considerable breakage of headers. The cause may be initial strains in sections set up when section is assembled at factory, pressure shock in feed water lines, temperature shock due to cold air coming up through openings in hopper under economizer or by expansion strains due to local conditions. When a factory assembled header breaks and is replaced by a hand assembled header, the latter seldom breaks. In order to avoid pressure shocks, every economizer installation should have an air chamber in the feed line. This chamber may consist simply of a dead end pipe connected to the feed line and carried well up above the economizer.

Manufacturers of economizers once advised by-pass flues for by-passing the gases around the economizer when repairs are being made. It has been found that generally there is not enough use for a by-pass to warrant its existence and, when once installed, a by-pass is a constant annoyance due to leaks and damper disarrangements. If the induced draft fans are to be worked by automatic control, it is advisable to place a damper in the economizer breeching. This damper, if properly tied in with the fan, will assist the fan in finding its proper draft balance.

Economizers Not Always Installed in Modern Plants.

As previously stated, economizers have never been fully accepted by the American engineering profession and many modern plants are being built with economizers permanently omitted. However, most of these plants, instead of truly eliminating the economizer, have really made it an integral part of the boiler itself. The most common method employed when economizers are omitted on horizontal tube boilers is to build the boiler several rows of tubes higher than standard and this additional heating surface really amounts to an integral steel tube economizer. With vertical tube boilers, the additional tubes are added to the rear tubes of the boiler. One advantage of this method is that the increased resistance to gas flow is so small that an induced draft fan is not required and by insulating the breeching and lining the stack, it is possible to run high ratings on stack draft without induced draft fans. Of course, it is always possible to get lower final stack temperatures by using an economizer and hence higher overall efficiency, but it is a much mooted question whether the net financial gain will always favor the installation of economizers. If it is decided to install economizers in a modern boiler house, a heat balance should be worked up very carefully to determine whether auxiliaries shall be steam or motor

driven. It is usually necessary to motor drive some of the auxiliaries in order to avoid an excess of exhaust steam in the heater such as would raise the feed water temperature above the most economical temperature for economizer operation.

CLASSIFIED LISTS OF U. S. PATENTS IN THE CARNEGIE LIBRARY OF PITTSBURGH.

The Technology Department of the Library is now able to offer an extremely valuable service to those interested in patents pertaining to the chemical and metallurgical industries. The Department has secured lists of the actual numbers of patents in forty-eight complete classes of the United States Patent Office classification. These classes comprise approximately two hundred thousand patents, covering, in general, the entire field of chemistry and metallurgy. Within these limits the list should enable anyone to make a complete patent search. This is a form of service not available elsewhere outside the Patent Office, since the indexes printed and distributed by the Patent Office are of little value in making a thorough patent search by subjects.

The lists are arranged by classes and sub-classes. The following will probably be of interest to readers of *The Blast Furnace and Steel Plant*:

- Class 22, Metal Founding. (Includes 219 sub-classes and contains approximately 5,867 patents.)
- Class 29, Metal Working. (Includes 189 sub-classes and contains approximately 6,572 patents.)
- Class 75, Metallurgy. (Includes about 16 sub-classes, containing approximately 1,350 patents on ferrous metallurgy.)
- Class 78, Metal Forging and Welding. (Includes about 103 sub-classes containing approximately 3,286 patents.)
- Class 80, Metal-Rolling. (Includes about 66 sub-classes, containing approximately 2,892 patents.)
- Class 148, Metal Treatment. (Includes 32 sub-classes, containing approximately 3,222 patents.)
- Class 158, Liquid and Gaseous Fuel Burners. (Includes about 121 sub-classes, containing approximately 8,444 patents.)
- Class 183, Gas Separation. (Includes 122 sub-classes, containing approximately 2,880 patents.)
- Class 184, Lubrication. (Includes 106 sub-classes, containing approximately 4,324 patents.)
- Class 202, Charcoal and Coke. (Includes about 10 sub-classes containing approximately 688 patents.)
- Class 204, Electrochemistry. (Includes sub-classes on electric furnaces and electrodes, containing approximately 1,224 patents.)
- Class 205, Metal-Drawing. (Includes 29 sub-classes, containing approximately 610 patents.)
- Class 207, Plastic Metal Working. (Includes 19 sub-classes containing approximately 379 patents.)
- Class 266, Metallurgical Apparatus. (Includes 42 sub-classes, containing approximately 2,000 patents.)

Saving Steam With Soot Blowers

Saving in Steam Effected by Valve-in-Head Soot Blowers—Charts Showing the Steam Consumption of the Soot Blowers When Operated for Varying Lengths of Time.

By ROBT. JUNE

ONE of the outstanding features of the new Valve-in-Head Soot Blower (Fig. 1) is the steam saving effected by the unit valve being open just long enough to have the jets pass over the part of the tubes to be cleaned. With the cam adjusted to hold the valve open for 300 degrees the head uses steam from five to seven seconds per revolution. As the gear reduction assures turning of the element slowly and steadily, it is rarely necessary to revolve the blower more than two

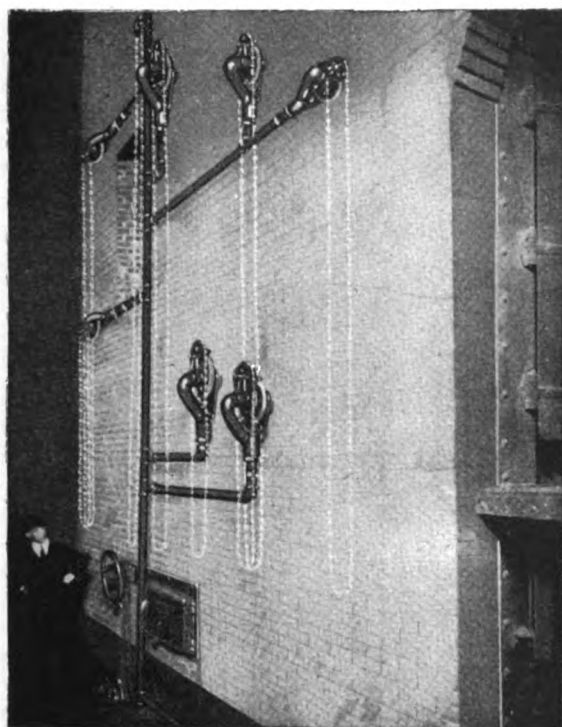


Fig. 1—Diamond Valve-in-Head Soot Blower.

or three times. This means that steam is being used from 15 to 21 seconds per unit per blowing.

In contrast the valve of the plain revolving soot blower is necessarily open from 45 to 75 seconds, 60 seconds being the average time required for close attentive operation.

At this point it is well to observe that very few men operating soot blowers realize the importance of giving proper attention to the steam loss due to unit valves being kept open longer than necessary to clean the boiler properly. We have timed a large number of soot blower operations, many of them without the knowledge of the operator, and it has been surprising to note the frequency with which the unit valves are kept open two and three minutes and even longer, while keeping the valves open

from a minute and a half to two minutes is common practice. Fig. 2 is a chart from which the steam loss from excessive blowing can readily be computed. The vertical column of figures at the left is the steam pressure in the header when blowing, while the figures at the bottom show the amount of steam that will pass through a standard 5/16-in. soot blower nozzle at the various pressures in a given time.

The point at which the slanting lines intersect vertical lines for a given pressure indicates the steam flow through the nozzle for the time marked on each slanting line. By this method we find that with 100 pounds header pressure, 2.4 pounds of steam will flow through a nozzle if the valve is open 30 seconds, while 9.6 pounds will be used if the valve is left open 120 seconds.

Taking a standard 21 wide B. & W. boiler, we find we have five units of 20 jets each, or 100 jets. To blow this boiler by the Valve-in-Head system with the valves open 30 seconds each will require 240 pounds of steam, while with the independent valve soot blower if the

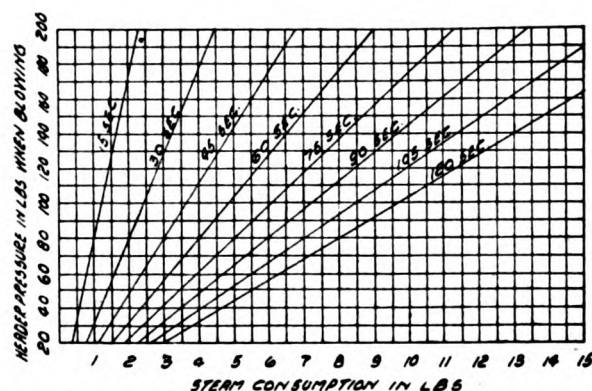


Fig. 2—Steam consumption for single 5/16 in. jet. Header pressure 40 to 120 lbs. when blowing. Valve open 15 to 120 seconds.

valves are open 120 seconds each, 960 pounds of steam will pass through. If the boiler can be properly cleaned with the valves open 30 seconds, the loss would be 720 pounds per blowing, or 2,160 pounds in 24 hours, if the blowers were used three times a day. With the boiler in service 300 days a year, the steam loss would be 648,000 pounds. To reduce this loss to dollars and cents it is only necessary to multiply the cost of the steam from 20 to 70 cents per thousand pounds, by 648. If the steam costs 50 cents per thousand pounds, the loss for the boiler described above would be \$324 per year.

The chart, Fig. 3, shows the total steam consumption for a five unit 21 wide installation, on which the header pressure is 100 pounds with the unit valves open from 10 to 130 seconds. Fig. 4 shows the total steam consumption of installations on a 21 wide boiler with

100 pounds header pressure, having from one to fifteen units and blowing from 15 to 120 seconds each. From this it will be seen that a boiler with 14 units, having 20 jets each, and with 100 pounds header pressure, will require 690 pounds of steam per blowing, if the valves are open 30 seconds each, while 1,725 pounds will be required if the valves are left open 75 seconds each.

It should be noted that the pressures given are for the

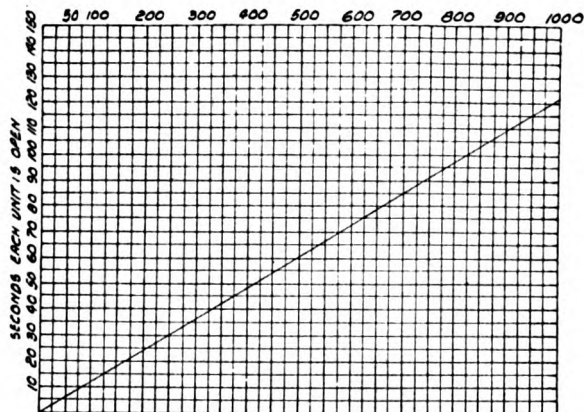


Fig. 3—Steam consumption in lbs. per 5 units on boiler 21 tubes wide. 100 lb. pressure when blowing.

header while blowing. With one unit valve open the header pressure will be from 50 to 80 per cent of the boiler pressure, depending on the size of the piping, the bends and valves in the line, the number of jets on the unit and other conditions. The header pressure will always be somewhat higher than the pressure in the blower element, due to friction between the header and

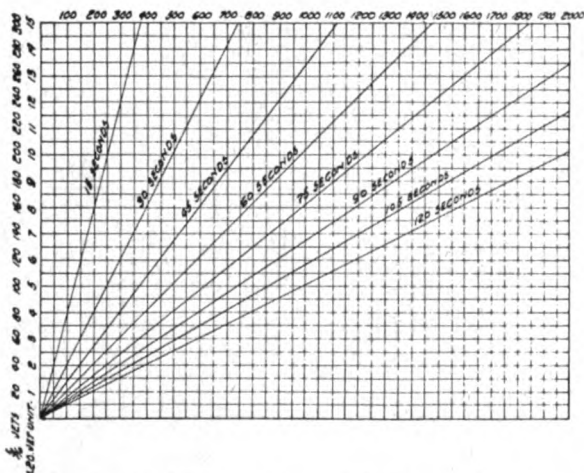


Fig. 4—Steam consumption per unit for boiler 21 tubes wide. Header pressure 100 lbs. when blowing. Valve open 15 to 120 seconds.

the element and in the element. This will also account for the discrepancies between these charts and the results obtained by the use of Napier's Formula.

These charts have been compiled from data collected while making tests on soot blowers at one of the largest power plants in the United States under conditions which assure their accuracy.

LETTERS TO EDITOR.

Dear Sir:

Statement published in your Journal of January, 1922, as follows:

"A trial by Bury at Skinningrove Iron Works published immediately after the war, to recover the ethylene from coke oven gases in the form of alcohol by absorbing the ethylene in 6 deg. Be Sulphuric Acid, have not been realized on a commercial scale, although great expectations were expressed in responsible quarters. The heat economy of the process is so unsatisfactory that almost as many heat units must be spent as are recovered in the form of alcohol."

The facts are in quite opposition to this statement.

The Skinningrove method, devised by Messrs. Bury, Ollander and Tidman for the recovery of alcohol, implements in every connection coke oven waste heat of no market value as against the expenditure of purchased fuel. It would only be true to state that if this heat had to be purchased, the recovery of alcohol would not be worth while. The process has not been abandoned as indicated in your Journal, although it has been delayed owing to the industrial upheaval during the past year in Great Britain, during which period the coking plants everywhere have been shut down.

Yours faithfully,

The Skinningrove Iron Co. Limited,
Ayna Hutchinson,
Managing Director.

Summer B. Ely, Prof. of Commercial Engineering,
Carnegie Institute of Technology,
Pittsburgh, Pa.

Dear Sir:

I have read with much interest in The Blast Furnace & Steel Plant Magazine, an abstract of your paper, "The Possibility of Improved Methods of Rolling Sheet Steel." The possibilities of a continuous sheet mill are indeed very interesting and no doubt will some day be realized.

You have given in your paper a description of a continuous sheet mill in the town of Teplitz in Northern Austria. This mill finishes 12 gauge sheets, 60 feet long and from 40 to 50 inches wide.

In connection with the rolling of 12 gauge plates or sheets I believe you will be interested to know about the Brier Hill Steel Co.'s 84 in. Plate Mill at Youngstown, Ohio. I was efficiency engineer at this plant and helped to work out some of the difficulties experienced in starting a new plant.

This is a tandem plate mill. The rougher is a two high motor driven reversing mill and is used in roughing down 3 in., 4 in. and 5 in. slabs. These slabs are then rolled, in a three high finishing mill, down to as low as 12 gauge. This mill is able to roll 12 gauge sheets, 36 inches wide and 40 or 50 feet long at the rate of 60 sheets an hour.

These sheets, however, on leaving the mill are buckled too much to make satisfactory sheets. This difficulty is entirely overcome by the use of a Hagan Costello Continuous Annealing Furnace. The sheets on passing through this continuous annealing furnace are heated to 1,600 deg. or 1,700 deg. F. and then are given three passes through cold rolls which makes sheets comparable to sheet mill product.

Many hundred of tons of sheet steel are rolled at this plate mill for automobile bodies, a product ordinarily considered a sheet mill product.

Very truly yours,

L. L. Darner.

NEWS OF THE PLANTS

The Hudson City Steel Corporation, 233 Broadway, New York, N. Y., is completing plans and will soon commence the erection of its proposed plant at Hudson, N. Y., where site has been secured providing an extensive acreage. The plant will consist of a series of six main buildings, each one-story, estimated to cost approximately \$1,000,000, including machinery. The works will be used for the manufacture of a general line of steel products. Dwight P. Robinson & Company, 125 East Forty-sixth street, New York, is engineer for the project, and bids will be asked from this office.

The Eastern Steel & Wire Company, Newark, N. J., recently organized under state laws with a capital of \$1,000,000, has purchased a tract of land on Evergreen avenue, near Frelinghuysen avenue, as a site for the erection of a new plant for the manufacture of general steel and steel wire products. A general building contract has been awarded to the American Concrete Steel Company, 27 Clinton street, Newark, for the erection of the initial plant unit, to consist of a main building 180x520 feet, and a number of smaller structures, estimated to cost approximately \$300,000, including machinery and operating equipment. Ground for the plant will be broken early in April and it is expected to have the plant ready for service early in the fall. Contracts for the machinery will be awarded in the near future. E. A. Henry, formerly connected with the American Steel & Wire Company, Pittsburgh, Pa., is president of the new corporation.

The Pidgeon-Thomas Iron Company, Memphis, Tenn., has completed plans for the construction of a new steel fabricating plant for structural and other iron-working. It will be one-story, 165x260 feet, and is estimated to cost close to \$75,000, including equipment. E. L. Harrison, Memphis, is architect and engineer in charge of the work.

The Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., a subsidiary of the United States Steel Corporation, has all of its blast furnaces in operation, with production in other departments on practically a 100 per cent basis. It is said that this is the first complete steel plant attaining full production during the past 24 months.

The Pennsylvania Tank Line, Argentine, Kan., manufacturer of steel tank cars and affiliated steel products, has broken ground for the erection of a new plant at Augusta and Fortieth streets, Argentine, Kan., to consist of three buildings. These will be a one-story steel fabricating works, 80x100 feet, and two adjoining buildings, 80x100 feet, and 40x45 feet, respectively. The general contract for the structures has been awarded to the Kansas City Structural Steel Company. Headquarters of the company are at 25 West Forty-third street, New York, N. Y.

The American Steel & Wire Company, Worcester, Mass., has filed plans for the erection of an addition to its plant on Fairmount avenue, New Haven, Conn., to cost about \$40,000. Improvements will be made also in the present building. The work will be placed under way at once.

The Carbon Iron & Steel Company, Parryville, Pa., is planning for the early resumption of production at its plant, which has been under curtailment for some time past. Improvements and repairs will be made to the main machinery and operating equipment.

The F. P. Smith Wire & Iron Works, Inc., 2346-Clybourn avenue, Chicago, Ill., has arranged for the erection of an addition to its plant for increased capacity. The new building will be three-story, 25x42 feet, and will be located at the rear of Clybourn and Chester avenues. A general building contract for the work has been let.

The Rhode Island Malleable Iron Company, Hills Grove, R. I., has completed plans for the erection of a new one-story plant at Providence, R. I., and will commence construction at an early date. It will be 67x250 feet, located on Narragansett avenue, and will be equipped for general production.

The Trumbull-Cliffs Iron Company, Warren, Ohio, is maintaining continuous operation at its new blast furnace, recently blown in. High production averages are being secured, totaling close to 500 tons of material a week. The output is being used at the plant of the Trumbull Steel Company, of which the company is a joint subsidiary with the Cleveland-Cliffs Iron Company, Cleveland, Ohio.

The Cambria Steel Company, Johnstown, Pa., has recently resumed production at the open hearth furnaces at its local plant. At the Franklin works of the company, 16 furnaces are in operation at the present time, while plans are being perfected for the early resumption of production at the plant at Bessemer, Pa.

The Boston Iron & Metal Company, Pratt Street, Baltimore, Md., has recently acquired the plant of the C. A. Gambill Manufacturing Company, Ellicott City, Md., which has been in financial difficulties. The new owner has given a stated consideration of \$410,000 for the property, and plans to utilize the works in connection with its general operations. Morris Schapiro is president.

The Youngstown Pressed Steel Company, Warren, Ohio, affiliated with the Sharon Steel Hoop Company, Sharon, Pa., has work under way on enlargements at its local plant for increased production. Additional equipment will be installed in certain departments of the works. It is expected to have the expansion completed and ready for operation at an early date.

The Swartz Manufacturing Company, Freeport, Ill., has been organized to take over and operate the business heretofore conducted by Carl H. Swartz, for the manufacture of iron products. A new shop building has recently been erected and will be used for general works expansion, particularly in the line of iron products for automotive service. Carl H. Swartz heads the new organization.

The Inland Steel Company, Chicago, Ill., is increasing production at its East Chicago, Ind., works, and has recently added about 1,000 men to the working force. The manufacture of steel rails has been resumed, and a number of the mill departments are now engaging on close to an 80 per cent basis. The company has secured an order from the Union Pacific Railroad Company for 350 tons of spikes, and also has booked a number of rail contracts.

The Ohio Steel Foundry Company, Lima, Ohio, has secured a large order for castings for the Argentine Republic, and has arranged for operations at a full capacity schedule at its local plant.

WITH THE EQUIPMENT MANUFACTURERS

NEW HAND POWER HOIST

Users of hand power hoists of five tons and larger capacity will be interested in a patented electric machine that may be suspended in the bight of the operating chain, having a capacity to overhaul 138 feet of hand chain per minute and chain pull of 130 pounds.

This gives a load lifting speed of approximately four times that obtainable by hand power and requires but one man for operation.

Current may be supplied by a flexible conductor from con-

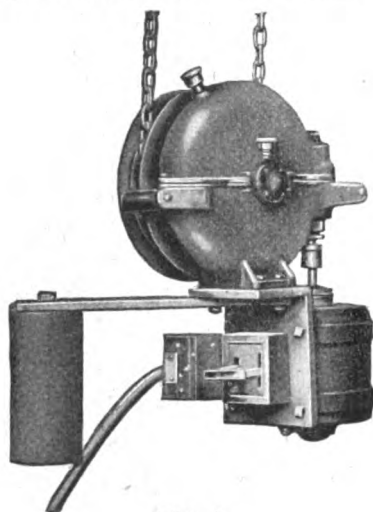


Fig. 1.

venient sockets or suspended from the hoist if more desirable to bring feeders to that point.

The machine balances itself, weighs about 160 pounds and is easily handled.

The gears are hardened and run in oil.

It can be furnished for operation on both alternating and direct current.

The machine is manufactured by the New Jersey Foundry & Machine Company, 90 West street, New York City, from whom more complete information may be obtained.

NEW GASOLINE POWERED LIFT TRUCK

A gasoline powered elevating platform truck embodying many unique construction features, to be known as the Clark Truklift, has been put in production by the Clark Trutractor Company, Buchanan, Mich., manufacturers of gasoline driven industrial trucks and tractors.

The Clark Truklift conforms in appearance and uses to the electric elevating lift trucks which have been used in industrial plants for many years, but low initial cost, ease of maintenance, flexibility, and continuous 24-hour service are distinguishing characteristics claimed for it by the builders, who are the pioneers in the manufacture of gasoline industrial trucks.

The loading platform is 26 in. wide by 54 in. long and will elevate its load of 4,000 lbs. from a minimum of 11 in. to a maximum of 16 in. from the floor in eight seconds; automatic stops provide for both up and down limits; elevation can be stopped by hand control lever at any point.

The lifting mechanism is operated by hydraulic pressure.

Power for locomotion and elevating the load is derived from a 15 hp. 4-cylinder tractor engine with a $3\frac{1}{8}$ in. bore and $4\frac{1}{2}$ in. stroke. The engine is mounted at the rear in a closed compartment containing transmission, governor, vacuum tank, radiator, etc.

A three-point suspension is used, the steering wheel forks being supported in a steel casting which is pivoted at the center of the frame on a chrome nickel steel pin 2 in. in diameter. The drive is through a Clark bevel gear axle equipped with ball and roller bearings located under the loading platform. Driving wheels are cast steel with pressed on rubber tires $10\frac{1}{2} \times 5$ in.; steering wheels are cast steel disc type with pressed on rubber tires $16 \times 3\frac{1}{2}$ in.

Standard automotive construction has been adhered to wherever possible so that the Truklift can be serviced by any good automobile or truck mechanic. The manufacturers claim as a very desirable feature the provisions that have been made for accessibility—a hinged hood renders the engine available for inspection instantly and if necessary the machine can be stripped down to the chassis in less than 20 minutes.

The driving and elevating controls are mounted on the rear of the engine compartment and are operated by the driver who drives standing. The brake lever pedal is under the driver's foot and so arranged that the Truklift stops automatically if for any reason the operator steps off while the machine is running.

The Truklift is the outgrowth of two years of development and testing work and is intended to meet the needs of those who require a full powered machine to work eight hours or more a day continuously in the transporting of materials in departmental or inter-plant haulage; it will climb a 10 per cent grade with a 4,000-lb. load and has two speeds in each direction.

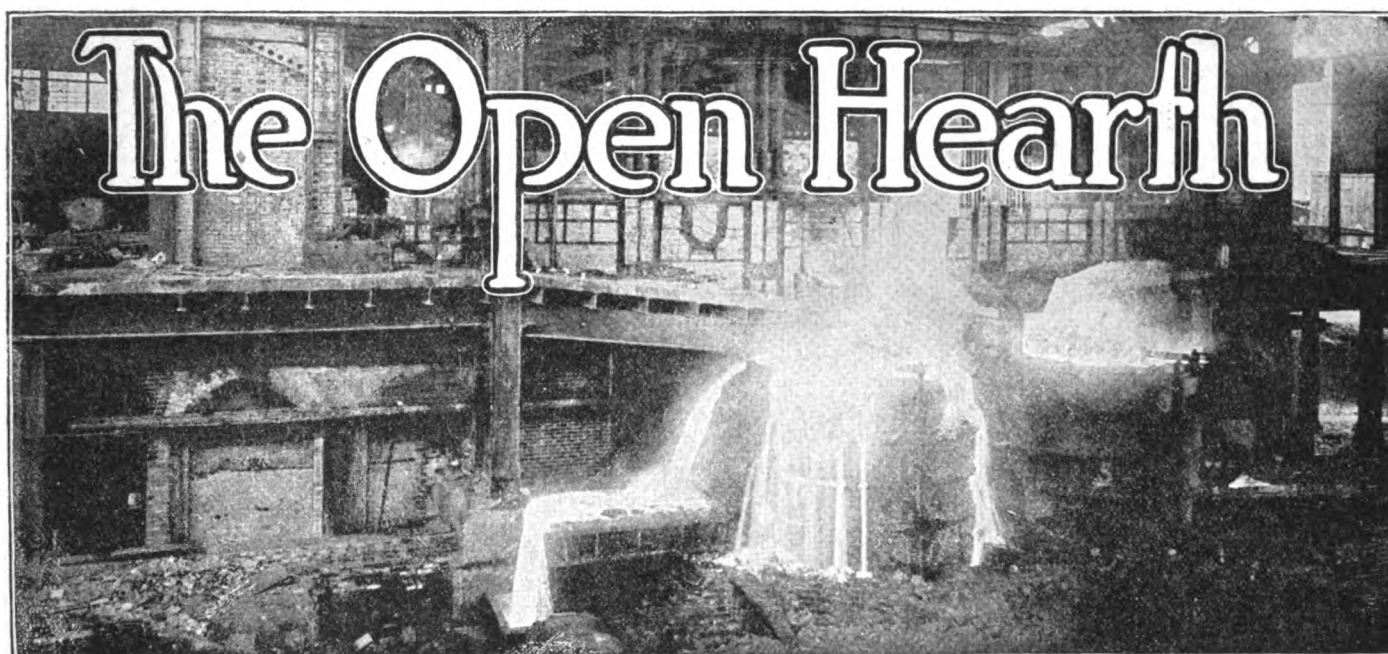
The total weight of the Truklift ready to go to work is 2,500 lbs.; over all length of machine is 107 in.; width $35\frac{1}{2}$ in. and height 51 in.

WHEN "FREE AS AIR" LOSES ITS MEANING

Air when compressed and converted into a form of energy and power ceases to be "free"; fuel, machinery, equipment, and labor enter into making it an item of cost. And cost of compressed air greatly rises through any waste by leakage before final distribution to the tool which it operates or to the points of its ultimate use. Due to leakage through joints in piping, valves, split pipe, defective castings, and wastage at a tool or machine, the over all efficiency of compressed air is very often reduced 40 to 60 per cent throughout the system.

Jenkins Brothers, manufacturers of Jenkins Valves, have recently perfected and are now marketing a brass air gun, which is air-tight and an assurance against costly air waste. The Jenkins renewable disc with which this air gun is fitted is an innovation in equipment of this kind, and is especially suited for air service. The disc forms a perfect contact on the seat and takes up the wear of frequent usage. The disc gives long service, but can be easily and quickly renewed if necessary.

This air gun is finding wide use in foundries for blowing off cores, cleaning core boxes, flasks, patterns, and for general dusting. In machine shops for blowing off chip boring filings, trimmings, and for cleaning tools, taps, dies, etc.—and in wood working mills, textile mills, electrical stations, garages—everywhere that a blast of air is required.



Col. Arthur S. Dwight, New York, the new president of the American Institute of Mining and Metallurgical Engineers, is a leading figure in the Federated American Engineering societies. He is a graduate of the Columbia School of Mines, where he obtained his degree in 1885. Col. Dwight has been active in the Anglo-American movement to promote world peace through the cooperation of engineers throughout all countries. He is a former trustee of Columbia university and is secretary of the general committee of trustees, faculty and alumni of the Columbia School of mines. Col. Dwight was a member of the American mission which went abroad last summer to confer the John Fritz gold medal upon Sir Robert Hadfield in England and Eugene Schneider in France.

V V

Martin Harder has become affiliated with the South Side Malleable Castings Company, Milwaukee, Wisconsin. Mr. Harder was formerly superintendent of the malleable department of the Chain Belt Co., Milwaukee, and more recently connected with the Saginaw Malleable Iron Co., Saginaw, Michigan.

V V

C. D. Watson has opened an office at 407 Mahoning Bank Building, Youngstown, Ohio, where he will handle sheets and sheet mill by-products under the name of the Watson Bros. Steel Company. Mr. Watson was formerly vice president of the Sheet Metal Mfg. Company, Youngstown, Ohio.

V V

C. Rogers, formerly superintendent of the Michigan Gray Iron Casting Company, Detroit, has been made night superintendent for the Monroe Steel Casting Co., Monroe, Michigan.

V V

John McConnell has again become affiliated with the United Alloy Steel Corporation, Canton, Ohio, as vice president in charge of operations. He gained distinction in the early days of the United Steel Company, later merged in the United Alloy Steel Corporation, in producing the first vanadium steel in commercial quantities. His experience comprises ten years with the Carnegie Steel Company, three years with the Bethlehem Steel Company, eleven years with the United Steel Company when he was general superintendent, one year with the Central Steel Company as consulting metallurgist, and three years as vice president in

charge of alloy steel production with the Interstate Iron & Steel Company, Chicago.

V V

The Westinghouse Electric & Mfg. Company recently announced several changes in the personnel. R. L. Rathbone, who has been manager of the Cleveland office, will take up special duties in connection with merchandising matters, with headquarters in Cleveland, and is succeeded by J. Andrews, Jr., who has been manager, industrial division, Pittsburgh office. R. Seybold has been appointed manager of price statistics and will act as secretary of the domestic sales committee. W. R. Keagy has been appointed manager of the Cincinnati office and J. R. Deering manager of the Los Angeles office. H. S. Walker succeeds H. E. Lanning as promotion man in the Denver office and I. G. Cline takes the promotion work vacated by R. A. O'Reilly in the Chicago office. K. L. Graham succeeds to the post vacated by H. C. Hopkins as promotion man in the San Francisco office.

V V

E. M. Griffiths, the founder of the Burton Griffiths & Co., Ltd., of London, England, has resigned his position as managing director and chairman of that business and has also retired from the board of the Birmingham Small Arms Co., Ltd., so that he is no longer associated with the control of either company. His city address is now 30-32 Ludgate Hill, London, E. C.

V V

Joseph H. Roberts, Midvale Steel & Ordnance Company, Nicetown Works, has resigned to become assistant to the president of the Electric Alloy Steel Company, Youngstown, Ohio.

V V

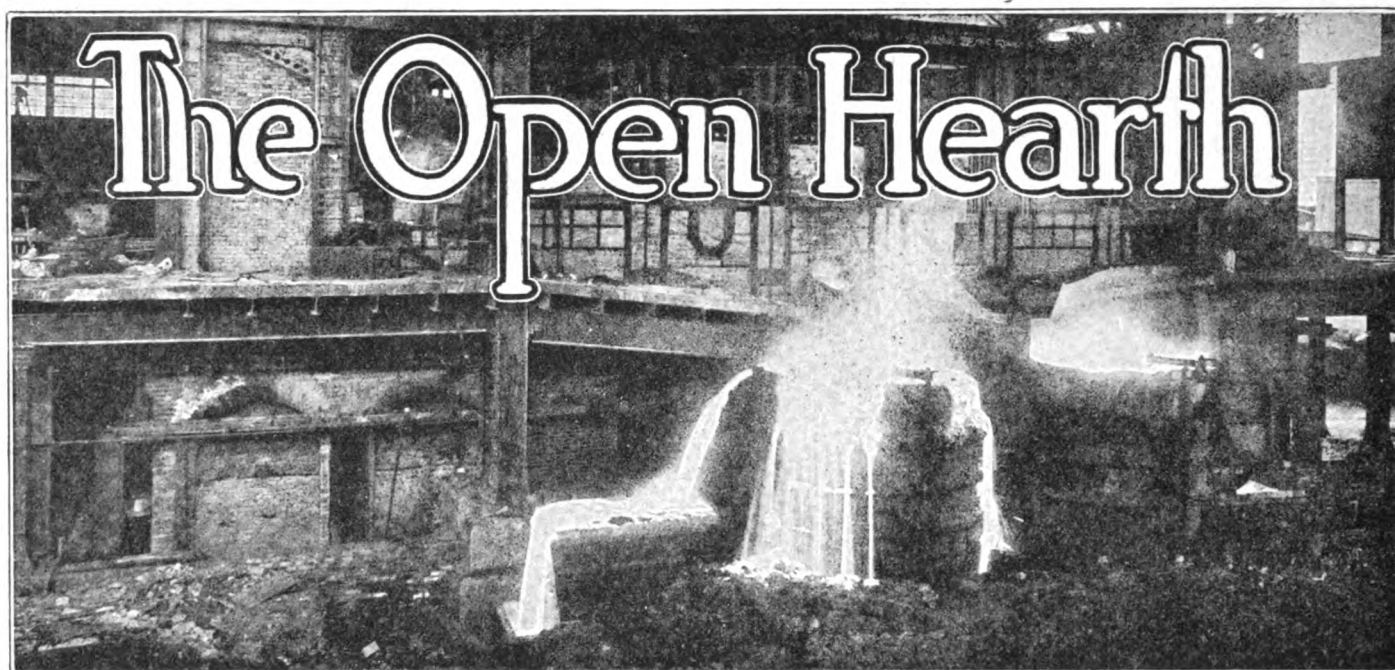
John F. Mazen has been appointed assistant general manager of sales of the Pittsburgh Steel Company, Pittsburgh, Pa. Mr. Hazen has been connected with the above named company for several years in the capacity of sales.

V V

Samuel E. Duff, consulting engineer, Pittsburgh, has been elected president of the Memphis Steel Construction Company, Magee Building, that city. For some time past has been that company's consulting engineer. He succeeds C. A. Hunt.

V V

Samuel R. Robinson recently resigned as foundry super-



intendent of the Sandusky Foundry & Machine Company, Sandusky, Ohio, to become metallurgist with the Lorain Foundry Company, Lorain, Ohio. Previously, Mr. Robinson had been metallurgist for the Philadelphia Roll & Machine Company, Philadelphia, and the Duquesne Steel Foundry Company, Coraopolis, Pa.

V V

J. C. Miller, Manager of the Columbus, Ohio, division of the American Rolling Mill Company, Middletown, Ohio, has been transferred to Ashland, Kentucky, as manager of the Ashland division, formerly the Ashland Iron & Mining Company which recently was taken over by the American Rolling Mill Company. In a recent organization of the Ashland Coal & Iron Railway Company, also owned by the American Rolling Mill Company, Mr. Miller was elected first vice president and general manager and his election as president of the Tygart Limestone Company, another subsidiary, also is announced.

V V

Thomas C. Ham, who has been looking after export business in the New York office of the Jones & Laughlin Steel Company, Pittsburgh, was on March 1st made assistant manager of exports under A. H. Holliday, manager of exports. He will remain in the New York office. Mr. Ham was born and raised on a New Hampshire farm and is a graduate of Dartmouth college. His first employment in the steel industries was with the American Steel & Wire Company as manager of its office in Oklahoma City from which he was promoted to assistant manager of the merchant trade department at the Chicago office. He went to the Jones & Laughlin Company in 1910 as assistant to the manager of sales of the wire department. During the war he was engaged in the promotion of all the Liberty Loan drives in Pittsburgh. Following this he was assigned to the New York office to look after export business.

V V

Robert C. Stanley, who was recently elected president of the International Nickel Company, is taking his new position with the responsibility of finding new uses for nickel. This is a particular need because of the effect of the disarmament agreement upon the consumption of nickel in armor plate. The company's development work will be consolidated and directed intensively. Mr. Stanley has spent

his entire business career with the International Nickel Company. He became assistant superintendent of the American Nickel Works at Camden, N. J., when that company was taken over from Joseph Wharton on the formation of the International Nickel Company in 1902. He subsequently became superintendent in charge of that plant and his next step was to become assistant general superintendent of the refinery at Constable Hook, N. J., later becoming general superintendent. In 1918 Mr. Stanley was made first vice president of the company, in full charge of all operations in this country and Canada. He was elected president March 1st. He was graduated from Stevens Institute in 1899 with the degree of mechanical engineer and from Columbia School of Mines in 1901.

V V

A. H. Murphy, superintendent of the American Rolling Mill Company plant at Zanesville, Ohio, has been promoted to be plant manager and W. R. Barnett, assistant superintendent, has succeeded Mr. Murphy.

V V

G. M. Black, formerly blast furnace superintendent of the Alan Wood Iron & Steel Co., Swedeland, Pa., will leave for Spain about April 1st where he will become connected with the Compania Siderurgica del Mediterraneo, as superintendent in charge of blast furnaces.

V V

C. D. Claney was recently elected secretary and treasurer of the Superior Steel Corporation, Pittsburgh, at its recent annual meeting in New York City. Mr. Claney was formerly affiliated with the Crucible Steel Company of America, Pittsburgh. As secretary, he succeeds H. D. Sarge who resigned recently as secretary and assistant treasurer. At that meeting, President E. W. Harrison was re-elected and E. H. Forster, formerly vice president and treasurer, was re-elected vice president. Donald M. Liddell was re-elected assistant secretary and assistant treasurer.

V V

William H. Weichsel recently resigned as superintendent of the Dover, Ohio, mill of the American Sheet & Tinplate Co., effective April 1st, to become manager of the Inland Steel Company works at Indiana Harbor, Ind. Mr. Weichsel has been superintendent at Dover since 1916. W. H. Ashbaugh of Leechburg, Pa., has been appointed to succeed him.

Some Pointers on By-Product Coke Oven Operations

HANDLING OF A COKE OVEN PLANT DURING A DISPUTE

In an inaugural address to the North of England Branch of the Coke-Oven Managers' Association, Mr. A. H. Thwaite dealt with three methods to be adopted during a dispute, viz., drawing only enough ovens to maintain gas supply for heating the oven walls, beehive by-product coke ovens, and the total shutting down of ovens and plant, leaving hot coke in the ovens.

In respect to the former, advantages would be in keeping the oven heats such, that the remainder of the battery could be rapidly restarted upon resumption of work, thus avoiding hand-firing or beehiving, and reducing serious contraction of brickwork. On the other hand, there is risk of not maintaining an adequate supply of gas; expense in disposing of the coke, loss in benzol, and difficulty of procuring labor, are other disadvantages.

Apropos the second method, carbonization could be extended over a longer period, heats could be rapidly increased, and there would be no serious contraction of brickwork. As a set-off, however, the coke, which would not always be good, would be expensive to stock, and there would be a serious loss in by-products, and risk of damage to the brickwork.

In shutting down, any advantages would depend on whether arrangements were made for flues to take gases direct from the ovens into wall combustion flues, thence to the main flue and chimney. Hand-firing would be essential, but would have its attendant dangers, and although advantages would be the saving of coal and by-products, more economical as regards labor, power, and facilities for repair, against same there would be the loss of coke, labor cost for hand-firing, and contraction of brickwork.

It is suggested that the most economical way would be to erect suitably designed gas producers, equipped with mechanical means for charging fuel, etc. Only a small quantity of hot coke would be necessary to enable rapid restarting, and although the capital cost might be heavy, it would soon be recompensed as compared with the expenses for hand-firing on the three previous systems mentioned.

BUREAU OF MINES INVESTIGATES USE OF VARIOUS COKES IN BLAST FURNACE

The blast furnace research section of the Bureau of Mines, located at Minneapolis, has carried out plant investigations for six years; these are being continued. The conviction has been forced on it, however, that little progress toward the solution of the many important problems involved in furnace operation will, or can, be solved by any method of study of commercial operations on account of the large amount of materials to be handled and the numerous causes of irregularities. The need of a furnace capable of operating on a small scale and under controllable conditions has been obvious for years. In the last year an experimental stack has been erected and 12 combinations of furnace lines and operating conditions tried out. This work is being continued.

One investigation covers the effect of furnace lines on blast furnace operations. The blast furnace works on the counter-current principle; the ascending gas stream encountering the descending raw materials, with a regenerative transfer of heat.

Maximum contact between gas stream and raw materials produces most rapid heat transfer and reduction of the ore. The degree of contact between gas stream and solid charge depends to a very large extent upon the size and shape of the furnace. About 200 furnaces are relined each year, most of the new lines being copies of previous unsatisfactory ones. The furnace designer, lacking practical rules governing the best shape of furnace, prefers to stick to known troubles rather than accept the risk of a new design. An investigation in the laboratory and in the experimental furnace is being carried on by the bureau with the hope to discover some fundamental principles which may be of use to the furnace designer.

Another investigation being conducted relates to the effect of physical characteristics of the charge on blast furnace operation. Probably the greatest cause of the fundamental inefficiency of the blast furnace, considered thermally as a furnace, is due to the enormous disparity between the sizes of the particles of the solids charged. The average lump of coke has a volume of 400 to 800 cc. and a surface exposed to the gas stream of 0.5 to 1 sq. cm. per gm. The average ore particle, on the contrary, has a volume approximately 0.000005 and would expose a surface of about 300 sq. cm. per gm. to the gas stream if its surface were exposed to the gas stream. A study is being made of the effect on furnace operation of a mixture of solid particles one-third of which is one hundred million times the size of the other two-thirds. In a number of cases furnace operators have improved furnace efficiency by sizing the coke charge. There are prospects of being able to continue such work on the sizing, not only of the coke but of the ore.

The bureau is also conducting performance tests on various cokes in the blast furnace. Opportunities for obtaining rather complete data on coking conditions and co-ordinate information concerning the performance of this coke in the blast furnace are particularly good at this plant. Variations in the quality of the coke in commercial practice are sufficiently great to promise valuable data without instituting special coking conditions. Furnace irregularities from other causes probably will be difficult to eliminate. Chances of a successful study of data at this plant are better than at the majority of plants due to the simple and direct means there employed for the transfer of coke from the ovens to the furnace. In most plants the identity of individual coke heats is lost in transfer and storage of the coke.

COAL AVAILABLE IN CASE OF STRIKE

An analysis of the coal situation, the purpose of which is to give business men information regarding possible fuel supplies in the event of a strike of miners on April 1,* has been issued by the Coal Bureau of the Natural Resources Department of the Chamber of Commerce of the United States. The bulletin carries charts covering conditions in particular localities.

As the anthracite field is 100 per cent unionized, all supplies in the event of a complete closing of the mines will have to be drawn from stocks on hand. Reliable figures on which to base an estimate covering possible anthracite supplies in the event of a strike completely closing the mines are not available.

Assuming this year's bituminous consumption to be comparable to that of 1921, 7,600,000 tons per week, the supply from non-union fields would fall short 3,600,000 tons per week of meeting the demand.

TRADE NOTES

The County Gas Co., of Atlantic Highlands, N. J., has determined upon comprehensive improvements to its plant and to that end has awarded the contract for the entire work to The U. G. I. Contracting Co., of Philadelphia. In general, the improvements will include remodeling of all of their water gas apparatus, including the installation of new generators and air and steam controls. There will also be installed a new turbine blower plant with blast main system, 300-H.P. water tube boiler, take-off main, exhauster and connection, together with a building for same, Venturi meter, 50,000 gallon capacity oil storage tank and steel purifier 21 ft. diameter by 16 ft. 4 in. high. Necessary pipe connections are included for the various apparatus.

Mr. Noel Cunningham, formerly connected with the Coal Washing Equipment Co. has now become associated with the Hardinge Company, Incorporated, 120 Broadway, New York, N. Y. This change is due to the acquirement by the Hardinge Company of all manufacturing and sales rights of the James Coal Washing Equipment, formerly handled by the Coal Washing Equipment Co.

The condenser and purifier systems at the South Bend Works of the Northern Indiana Gas & Electric Co. are to be enlarged and remodeled. The contract for this work has been awarded to The U. G. I. Contracting Co., of Philadelphia. This Company has also received the contracts for installing scrubber condensers at the Frankfort, Ind. and Peru, Ind. plants of the same Company.

Frey, Brassett & Company, Chicago, have been retained by the Trumbull-Cliffs Furnace Company in connection with extensions to electrical power output at the Warren Blast Furnace Plant; by the Kailan Mining Administration, China, as consultants in concentration and mill tests on their low grade magnetic ores.

The Orton & Steinbrenner Co. of Chicago and Huntington, manufacturers of locomotive cranes, clam shell and orange peel buckets and coal crushers have made arrangements with J. Ross Bates, formerly connected with Wonham, Bates & Goode Trading Corp., of N. Y. and Boston to represent them in the New England States and New York City. Mr. Bates has offices at 136 Liberty St., New York City and 128 School St., Watertown, Mass.

The Diamond Soot Blower business has been purchased by new interests in the form of the Diamond Power Specialty Corporation of Detroit, Mich., a new company which has taken over the busi-

ness and plant of the Diamond Power Specialty Co., co-partnership, the members of which are retiring from the soot blower business in the Western Hemisphere. Mr. Norman L. Snow, President and Treasurer of the new company, resigns his position as Vice President and active head of the Terry Steam Turbine Co. of Hartford, Conn., with whom he has been connected for the past thirteen years. Mr. Snow is a graduate of Yale Scientific School and Massachusetts Institute of Technology, and has been in the power plant field for the past eighteen years.

The Gas Combustion Company of Pittsburgh, Pa., have recently filled its fifth repeat order for Bradshaw burners at Jones & Laughlin Steel Company, Aliquippa Works at Woodlawn, Pa. This plant is now completely equipped with Bradshaw Patented Blast Furnace Gas Burners. The Gas Combustion Company also recently equipped three (3) 250 H.P. Cahall boilers at New Castle Steel Works and Furnaces, New Castle, Pa., with Bradshaw Patented Blast Furnace Gas Burners.

Whiting Corporation established their own branch sales office in New York City at 136 Liberty St. (Phone Rector 9825), having discontinued their agency agreement with Wonham, Bates & Goode Trading Corp., N. Y., who formerly represented us in the East. Mr. J. Ross Bates, now a Vice President of Whiting Corp., is in charge of the new office. He will be assisted in the New York territory by Mr. D. Polderman, Jr., and in the New England States by R. C. Maley, who will open an office at Springfield, Mass. All of these gentlemen were formerly associated with Wonham, Bates & Goode Trading Corp.

The Union Steel Casting Company of Pittsburgh has purchased at private sale a large block of capital stock in the Pittsburgh Rolls Corporation of the same city. The plants are both located in the Lawrenceville District, and it is the intention of the Union Steel Casting Company in making this purchase that the two companies shall work in close harmony, and that no changes whatever be made in the local organization or management of the Pittsburgh Rolls Corporation, other than certain directors who will be retired by reason of the purchase will be replaced by officers of the Union Steel Casting Co.

The Pittsburgh Rolls Corporation (Phoenix Roll Works) has operated in the same locality for over 50 years. It was first under the name of Bowman, Boyd and Bagley, then as James B. Young & Company, and later as Seaman Sleeth and Company, who operated for a great many years, being succeeded in 1917 by the Pittsburgh Rolls Corpora-

tion. During all these changes the plant has been known as the Phoenix Roll Works; and Phoenix Rolls are familiarly known by every rolling mill in the United States, and generally throughout the world. The present officers are D. L. Eynon, President; Q. S. Snyder, Vice President and Treasurer; P. M. Fleming, Secretary. The Union Steel Casting Company was organized in 1899, and has grown from a very small beginning to one of the leading steel foundries in the country. The officers are C. C. Smith, Chairman; J. P. Allen, President; J. B. Henry, Vice President and General Superintendent; S. H. Church, Vice President; G. W. Eisenbeis, Treasurer; W. C. Eichenlaub, Secretary.

TRADE PUBLICATIONS

The Damascus Tool Company have issued a very attractive catalogue descriptive of "Damascus Tools." Complete information of the company's products which consist of rivet sets, punches and dies can be obtained from this booklet. It will be sent upon request to the company.

The Morgan Engineering Company of Alliance, Ohio, have issued a new "Soaking Pit Crane Bulletin" which is very interesting. It is well illustrated with views showing a number of Morgan installations in steel plants.

The Surface Combustion Co. of New York announce that they now have ready for distribution "No. 3D on Surface Combustion Low Pressure Air-Gas Inspirators. These inspirators are designed so as to be readily applicable to any make of gas furnace.

The H. K. Porter Co. of Pittsburgh, Pa., have issued an exceptionally interesting catalogue descriptive of "Porter Fireless Steam Locomotives." This locomotive is an innovation which has proven its value. It is a steam locomotive without boiler and firebox. In place of a boiler, it carries a tank containing water which is heated by steam from a suitable stationary boiler. It is ideal where trips are too infrequent and too irregular to justify the expense of a steam locomotive of usual type.

The Ideal Electric and Manufacturing Company of Mansfield has just issued two very complete bulletins, one describing their Alternating Current Motors and the other their Direct Current Motors. Either will be sent upon request.

The U. P. C. Book Company announce a new book published February 1st, 1922, "Best's Burning of Liquid Fuel." It is a practical treatise on the perfect combination of oils and tars, giving analyses, calorific values and other data.

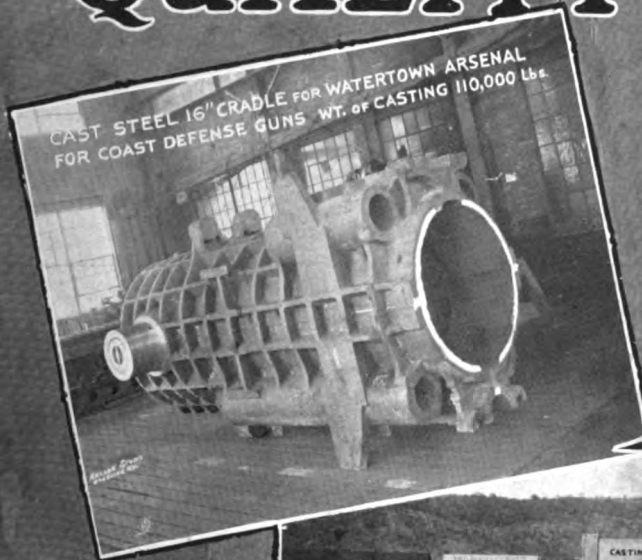
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The Blast Furnace *and* Steel Plant

Pittsburgh, April, 1922.

WHEELING QUALITY CASTINGS



Wheeling Mold & Foundry Company Wheeling, West Va.

PENINSULA PLANT

WARWOOD PLANT

MANCHESTER PLANT

Capacity Per Month	
Steel Castings and Steel Rolls.....	3000 Tons
Iron Castings.....	1000 "
Sand and Chilled Iron Rolls.....	1000 "
Small Iron Castings.....	500 "